EXPLORING KNOWLEDGE MANAGEMENT IN THE PRACTICE OF ARCHITECTURE: A PILOT STUDY FROM THE TURKISH CAPITAL

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ABSTRACT

EXPLORING KNOWLEDGE MANAGEMENT IN THE PRACTICE OF ARCHITECTURE: A PILOT STUDY FROM THE TURKISH CAPITAL

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Architecture-Engineering-Construction industry has recently been altering the ways of managing its resources. Knowledge is considered to be among the most precious of these resources. Knowledge is a critical factor in choosing the right projects, preparing the winning bids and successfully realizing the projects. It is also a critical factor for organizations because of the fact that - due to its nature that it exists as tacit or explicit, or in between - it is hard to record and reuse.

This study investigates the knowledge management issue in the practice of architecture. Face-to-face interviews have been carried out with 15 architectural offices in Çankaya district of Ankara. The subject domain is assumed to be experiencing problems such as managing knowledge at a strategic level. This is due to the facts that the amount and importance of tacit knowledge is significant and communication of this knowledge to other parties is the responsibility of the architectural partners.

The survey found out that management of architectural knowledge is considered to be beneficial for the overall productivity of architectural offices. However, challenges such as lack of standard procedures and low profit margins in the AEC industry render this activity to be less effective on profit and innovation in design.

Keywords: architecture, knowledge management, office, information technology

ÖZ

MİMARLIK MESLEK PRATİĞİNDE BİLGİ YÖNETİMİNİN İNCELENMESİ:
TÜRKİYE BAŞKENTİNDEN BİR PİLOT ÇALIŞMA

Kayaçetin, Nuri Cihan

Yüksek Lisans, Mimarlık Bölümü, Yapı Bilimleri

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Günümüzde inşaat endüstrisi, kaynaklarının nasıl yönetildiği konusunu gözden geçirmektedir. Bu kaynaklardan en önemlileri arasında bilgi yer almaktadır. Bilgi, doğru proje seçmekte, kazanan ihaleleri hazırlamakta ve projeleri hayata geçirmekte vazgeçilmez bir öğedir. Bilgi, aynı zamanda, doğası bakımıyla insanların zihinlerinde veya belgelenmiş olarak ya da bu iki durumun arasında bulunabildiğinden dolayı kayıt edilmesi ve yeniden kullanılması zor bir öğedir.

Bu çalışma, mimarlık meslek pratiğinde bilgi yönetimi kavramını incelemektedir. Ankara'nın Çankaya semtinde bulunan 15 mimarlık bürosuyla karşılıklı görüşmeler düzenlenmiştir. Seçilen araştırma grubunun bilgi yönetimi konusunda stratejik düzeyde sorunlar yaşadığı varsayılmıştır. Bunun nedenleri olarak, tasarım sürecinde yararlandıkları bilginin daha çok insan zihninde bulunması ve bu bilginin taşıdığı kayda değer önem, ayrıca bu bilginin diğer iş ortaklarına aktarımının mimari ofislerin sorumluğunda olması gösterilebilir.

Çalışma sonucunda, mimari bilginin yönetiminin mimarlık ofislerinin genel üretkenliğini arttırabileceği saptanmıştır. Ancak, düşük kar oranlarını ve sektörde standart prosedürlerin bulunmayışı gibi sebepler yüzünden bilgi yönetiminin mimari ofislerin kar düzeyleri ve mimari tasarıma olan katkılarının az olduğu görülmüştür.

Anahtar kelimeler: mimarlık, bilgi yönetimi, ofis, bilgi teknolojileri

To My Parents

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Finally, I would like to express my deepest thanks to my family, my parents and my brother, for their enduring love and support, which gave me the inspiration to complete this study. And special thanks to my fiancée Berna, from whom I have always received spiritual support and strength all the time by sharing her unique friendship.

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ABBREVIATIONS	
AEC	- Architecture – Engineering – Construction
AI	- Artificial Intelligence
AIA	- American Institute of Architects
BIM	- Building Information Model
CAD	- Computer Aided Drawing
CD	- Compact Disk
DVD	- Digital Versatile Disk
HRM	- Human Resource Management
IT	- Information Technology

CHAPTER 1

INTRODUCTION

In this chapter, the argument for and objectives of the study being reported herein are first presented under respective sub-headings. Again under a dedicated subheading, it continues with a brief overview of the general procedure followed in its conduct and ends with a concise description of what is covered in each of remaining chapters, under the sub-heading titled "Disposition".

1.1. Argument

"Human activity is inconceivable without knowledge", Quintas (2005, p.10) states, and one can only agree with him. The author adds that creating, accumulating, sharing and applying knowledge have enabled the civilization to rise and survive. Possessing this much of importance for the living, we may as well claim that managing knowledge has a long time history.

Today, knowledge is considered as the most important asset for the business organizations. The phenomenon is attracting both academia and industry and there is a significant amount of research effort devoted to the management of knowledge. Knowledge is the center of attention due to the fact that business environment is changing significantly with the emergence of the knowledge era as a fundamental part of the global economy (Egbu and Robinson 2005, p.31). Although its value has long been neglected in organizations, knowledge is now regarded as a key factor for long-term corporate sustainability. Managing knowledge is imperative in converting it as an asset for organizational use to facilitate continuous improvement (Robinson et al., 2005).

As the conditions above affecting the overall business environment, especially large organizations have taken the necessary steps for establishing knowledge managing environments. Some of the first initiatives of knowledge management are in firms such as BP, Chevron, Shell, Hewlett Packard, Buckman Labs and Xerox (Quintas 2005, p.10). Subsequently, many other organizations from various industries have given due attention to the knowledge management implementations. In this respect, organizations are seeking for ways to understand the nature of knowledge they possess and develop methods to utilize it at maximum performance.

One of the largest industries among which knowledge has seen a great deal of attention is the architecture, engineering and construction (AEC) industry. As of today, Sheehan et al. (2005, p.50) state that AEC industry demands results faster than ever and individuals are exposed to significant pressure due to the need for rapid communication through advanced tools. Also, the AEC industry is large and very competitive and displays low profit limitations. This competitive environment makes managing of knowledge to appear particularly attractive. Kamara et al. (2002) define the AEC industry as a project-based industry which utilizes a variety of separate firms in a temporary multi-disciplinary organization in order to produce investment goods (buildings, roads, bridges, factories) that are custom built to unique specifications. In this respect, systematic management of knowledge can enable organizations to improve their overall productivity and gain competitive advantage by decreasing project durations, improving quality of products, increasing employee contribution and developing solid organizational knowledge repositories. On the other hand, Kamara et al. (2002) argue that should organizations fail to utilize project knowledge into knowledge assets, AEC organizations, especially temporary establishments, may have to re-invent the wheel, waste time and come up with weakened project performance.

Woo et al. (2004) state that much knowledge in the AEC industry is experience-based and resides in people's head and hard to manage due to the orientation toward unique projects. According to the authors, most of AEC knowledge is generated during the phases of design, planning, construction, and maintenance of a facility.

They also add that throughout the whole life cycle of a construction project, AEC firms rely on their experiences, professional intuition, and other forms of tacit knowledge to achieve adequate work. In this respect, tacit knowledge is one of the key elements for a knowledge management process.

The major reasons behind the need for knowledge-based strategies to be applied in the AEC industry are considered to be (i) the work culture that depends on social communication, (ii) limited data exchange standards caused by the fragmented nature of industry and (iii) the subjectivity of data structures. Woo et al. (2004) observe that, in an AEC organization, employees work on similar projects, but that does not necessarily mean that there is a tangible link between them. The authors claim that the top managers assume the AEC professionals already possess tacit knowledge and experience for specific types of projects. Assumption implies that experienced workers would share their knowledge and experiences with apprentices through informal communication. El-Diraby and Zhang (2006) point out that the increasing specialization in construction industry and high-level technical complexities of projects have created demands for more effective integration and communication means in the industry.

Developing and implementing a strategy for knowledge management in the AEC sector is considered challenging due to several reasons such as the uniqueness of construction projects, their temporary nature, and the complex interrelated activities required in achieving the objectives. Even though the conditions seem to hinder the implementations, in the AEC industry, knowledge management has been receiving due attention and been widely embraced. According to a survey of Udeaja et al. (2008) among UK project-based organizations, about 50% of the respondents noted that knowledge management would result in new technologies and new processes that will aid their organizations.

Competing in the international market, the construction companies in Turkey should also adopt adequate strategies and techniques in order not to fall behind their competitors. The AEC industry in Turkey is one of the main drivers of the economy,

as it is the case in most of the developing countries. The total ratio of construction industry in GDP is about %10-11 and it is claimed that when the side industries are included, this ratio rises to about %30 (Güneş et. al, 2004). The Turkish contractors are also fulfilling their roles as successful companies in the international area as well. In the AEC industry, architectural organizations are responsible from providing enormous amount of information in the collaborative project environment. Much of the construction works depends upon the work produced in the design stages. Architectural organizations organize the flow of knowledge and communication between clients and contractors, engineers and governmental bodies, office and construction site in order to provide construction site with valid and refined information. Architecture is a knowledge intensive business in that sense and therefore, managing architectural knowledge within the whole project life cycle is crucial. Due to the unique nature of architectural process, there is a need to explore the characteristics of knowledge and current strategies utilized in architectural organizations in order to develop better approaches.

1.2. Objectives

This study set to investigate the architectural practices in Turkey in the terms of knowledge management activities. It is imperative to observe the current methods of managing knowledge in Turkish architectural practice. By doing so, some specific objectives can be achieved, such as:

- Identifying the most frequently utilized knowledge sources
- Identifying the most common methods of sharing, accumulating and disseminating knowledge
- Identifying the expectations of Turkish architectural organizations for further development in the subject area
- Identifying the barriers against the development of Turkish architectural organizations in the subject area

1.3. Procedure

A general literature survey was conducted in order to identify the attributes of knowledge and methods of knowledge management. Characteristics of architectural knowledge were investigated. As a result, a framework for observing architectural organizations in the terms of knowledge management was prepared based on the study of Dikmen et al. (2005), which is given in detail in Chapter 3. Depending on this framework and literature survey, a questionnaire was prepared for face-to-face interviews with organizations. Architectural organizations were randomly selected among the offices in Çankaya District of Ankara which comprises roughly 8% of the sample space. Interviews were conducted with top management of architectural offices lasting between 45 minutes and 2 hours 15 minutes. In these semi-structure interviews, both qualitative and quantitative data were recorded for further analysis.

The survey aimed to observe the habitual and systematic activities which the architectural offices seem to be performing in the context of knowledge management. Knowledge sources, mechanisms of managing knowledge and approaches of organizations toward knowledge management were investigated. The problematic areas were underlined by the statistical analysis and subjected to further discussion. This process was also planned to create awareness on knowledge management for the offices to realize their current attitude towards knowledge and the possible improvements they could have done at the first instance.

Recommendations were proposed according to these findings. The combination of necessary knowledge management applications is going to provide a basis for a general framework for architectural offices in Turkey for improving their performance on managing the knowledge possessed and ultimately the overall performance in the Turkish construction industry.

1.4. Disposition

There are five chapters to this report. This first, containing the argument, the objectives and the procedure of the investigation, along with this disposition which summarizes what follows in the remaining chapters, gives a broad view of its most main aspects.

The second chapter consists of a literature review on general studies on knowledge, knowledge management and related techniques and tools used in managing of knowledge. The third chapter provides a thorough description of study material and methods used in both data collection and in its analysis. Here, comparisons are made through two sample dependent Student's t-tests. The fourth chapter then explains the specific result of the study, together with a discussion of these in terms of its objectives and relevant aspects introduced in the literature are given. The fifth chapter concludes the study by summarizing its findings and offering relevant recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

Introducing the concept of knowledge management would not be appropriate unless the definitions and distinctions between the core components; *data*, *information* and *knowledge* are clarified. As Davenport et al. (1998) state that it may be difficult to extinguish one from another but the human participation and perception leverages knowledge and information above the raw data. Moreover, the misconceptions on what data, information, and knowledge and wide range of opposing definitions for knowledge management have hindered expenditures of firms and results have rarely been as hoped or expected (Davenport and Prusak 1998, p.1; Carrillo and Chinowsky, 2006). Therefore, this chapter pays due attention to the definitions and past studies on these three concepts.

2.2. Data – Information – Knowledge

According to Davenport and Prusak (1998, p.2), "*data* is a set of disconnected, objective facts about events". The authors state that while the raw material of decision making may include data, it cannot tell you what to do. In an organizational context, data is records of transactions by itself that has little relevance or purpose.

Data becomes *information* when its creator adds meaning. Bhatt (2001) describes information as an organized condition of data shaped for a purpose, like many researchers described as giving a message or shaping the receiver, etc.

Knowledge has been described in several different ways. Patel et al. (2000) cited in Udeaja et al. (2008) state that knowledge is a body of information accompanied with understanding and reasoning. Udeaja et al. (2008) claim that knowledge can be extended to include the cognitive ability to create insight based on information and data, which is gained through experience and study. Definition of Davenport et al. (1998) suggests that knowledge is a high-form of information combined with experience, context, interpretation and reflection that can be applied for decision making in actions. A rather more comprehensive description is made by Davenport and Prusak (1998, p.5) as:

> "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating, and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms."

Bhatt (2001) agrees that defining data, information and knowledge is difficult. The author claims that the relationship between data, information and knowledge is recursive and depends on the degree of the "organization" and the "interpretation". Data and information are distinguished based on their organization and information and knowledge are distinguished based on their interpretation as shown in Figure 2.1.

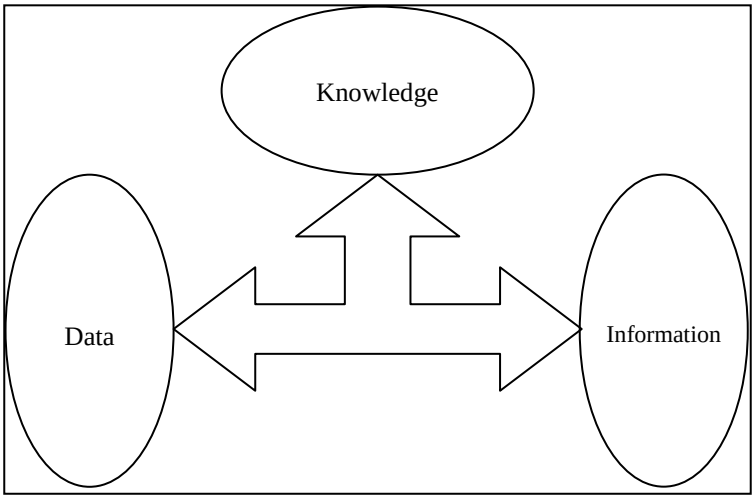

Figure 2.1. The recursive relations between data information and knowledge (Bhatt, 2001)

With the purpose of clarifying these contexts, Udeaja et al. (2008) dictate that it is important to draw a distinction between data, information and knowledge. The authors suggest a diagram proposed by Bellinger in 2004 as shown in Figure 2.2.

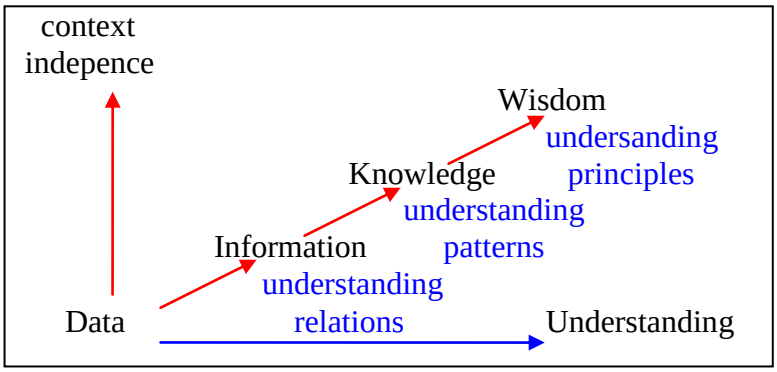

Figure 2.2. Knowledge graph (Udeaja et al., 2008)

Udeaja et al. (2008) argue that when a pattern relation exists between the data and information, the pattern has the potential to represent knowledge. The authors add that it only becomes knowledge, however, when one is able to realize and understand the patterns and their propositions.

The relationship between data, information and knowledge can be illustrated with some examples which is adopted and altered from the study of Bhatt (2001). Let's consider an architect and a simple business process including the phenomena: In the beginning of his project, the architect has got different sorts of data and information from several sources. There are expectations, descriptions which are expressed by the client and on the other hand, there are the obligations and regulations on the project site and time and finance. As the architect receives some information from the client, he considers those which are important for himself, for the project and for the client. Those that are not relevant 'information' with the project are discarded and become 'data'. Though, if the architect decides that he may not be sufficient for some parts of the project, such as interior design, and may call for an interior designer. The interior designer may find some discarded information rather relevant depending on his

experience, his knowledge base and may advice the architect to utilize them. This implies the architect needs to go back and forth from data to information and to knowledge in the process. The regulations and obligations can be considered as the information which tells the architect how to take certain actions in what conditions, but they cannot tell him how to build up a whole project. Though, the architect can relate the information from client with the information from regulations depending on his own experience and education and come up with the 'knowledge' which enables him to form up the adequate project design.

2.3. Explicit – Tacit Knowledge

Bhatt (2001) strongly expresses that knowledge can be considered as information or data if there is no meaning behind it. The author states that "it is only through meaning, that information finds life and becomes knowledge". Many researchers agree on the fact that only human interpretation can provide data and information with such meaning.

El-Diraby and Zhang (2006) derive three dimensions of knowledge from the definition of Davenport and Prusak (1998) such as "the known" (ontology), "the knower" (knowledge systems) and "knowing" (epistemology). Therefore, the authors claim that knowledge can be seen as the collection of objects and rules and best practices or as the procedure for learning and applying human knowledge upon dealing with objects. Tiwana and Ramesh (2001), cited in Udeaja et al. (2008) categorize knowledge in three sub-heading such as "general knowledge" that people gain through everyday experience and apply it without regard to any specific or direct relation; "domain specific knowledge" which is gained through study and experience; "procedural knowledge" which is gained from the experience of undertaking a task within a domain. Knowledge is a critical resource for industry, due to the several factors such as choosing the right projects, preparing winning bids and successfully carrying out the projects. In this respects, it can be claimed that the success of organizations is strongly based on their collection of knowledge about environmental factors, competitive organizations and best practices.

The distinction of knowledge as explicit and tacit was first introduced by Polanyi, cited in Woo et al. (2004) and Kivrak et al. (2008) and in many other sources. According to his definition, tacit knowledge is highly personal and context specific; therefore, it is not easy to codify and communicate. Nonaka and Takeuchi (1995, p.59) state that tacit knowledge is personal, context-specific, and hence is hard to document and share. Tacit knowledge can be shared and utilized through semi-structured communication means such as face-to-face contact, communities of practices, or lessons learned (Carrillo and Chinowsky, 2006). On the other hand, Polanyi cited in Kivrak et al. (2008) claims that explicit knowledge can directly be recorded in words and numbers, easily shared in manuals, and is easy to distribute. Koskinen et al. (2003) state that explicit knowledge is gained mainly through education and involves factual statements about material properties, tool characteristics etc. Some of the characteristics of explicit and tacit knowledge are shown in Figure 2.3.

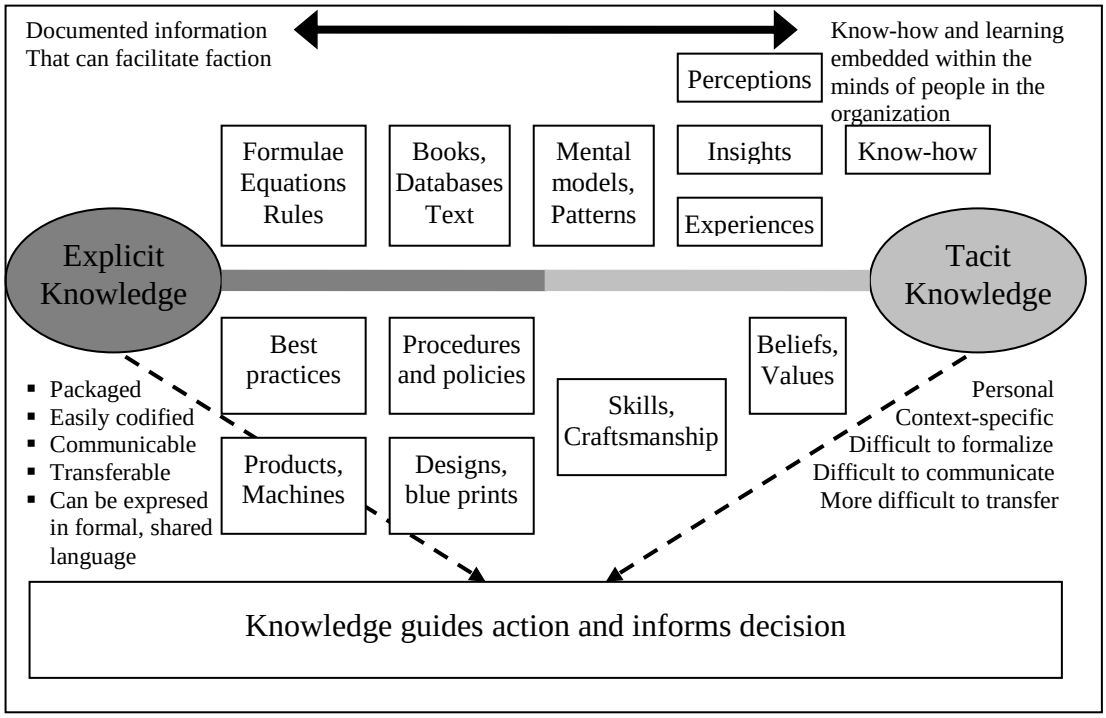

Figure 2.3. Tacit and explicit knowledge (Udeaja et al., 2008)

Nonaka and Takeuchi (1995, p.61) assume that human knowledge is created and expanded through social interaction between tacit and explicit knowledge. The authors claim that this social conversion process enhances both forms of knowledge in terms of quality and quantity. Both tacit and explicit knowledge is important for organizations; however, since Polanyi (1967) presented the first theory concerning tacit knowledge, numerous studies have demonstrated the importance of tacit knowledge. Also, Sternberg et al. (2000) hold that much of the knowledge needed to succeed in real-life events is tacit and experience-based. Since most know how, know what, and experience exist in the minds of people, capturing tacit knowledge of experts and engineers involved in projects and reusing in future projects is essential for the companies (Koskinen et al. 2003; Woo et al. 2004). Effective knowledge management is, therefore, highly vital for construction companies in order to prevent the loss of knowledge gained in the construction projects.

2.4. Knowledge Management

Knowledge management is process of creating value from an organization's intangible assets (Davenport and Prusak 1998, p.163). Cited in Carrillo and Chinowsky (2006), Webb (1998) defines it as "the identification, optimization, and active management of intellectual assets to create value, increase productivity and gain and sustain competitive advantage". Bhatt (2001) refers to knowledge management as a set of processes; knowledge creation, validation, presentation, distribution and application.

According to Woo et al. (2004) management strategies regarding knowledge assets are not as efficient as expected due to the fact that AEC firms are not as successful at tacit knowledge retrieval and sharing as they are at collecting and storing explicit information. The authors state that the industry has recognized the tacit knowledge as a critical resource for maintaining competitive advantage and firm growth, though especially geographically dispersed organizations do not seem to benefit from this valuable asset as anticipated.

As it is stated by Quintas (2005, p.10), the case is not that the organizational management processes occurred in the 1990s, even though it has come into common usage in the west during the last five years of the 20th century. The author states that it is just the acknowledgment of these processes which were unidentified in the past. Since its recent discovery, knowledge management has been subjected to research by both academicians and industrial organizations. Below in Figure 2.4, the number of knowledge management articles through 1990s is seen at a rapidly increasing rate.

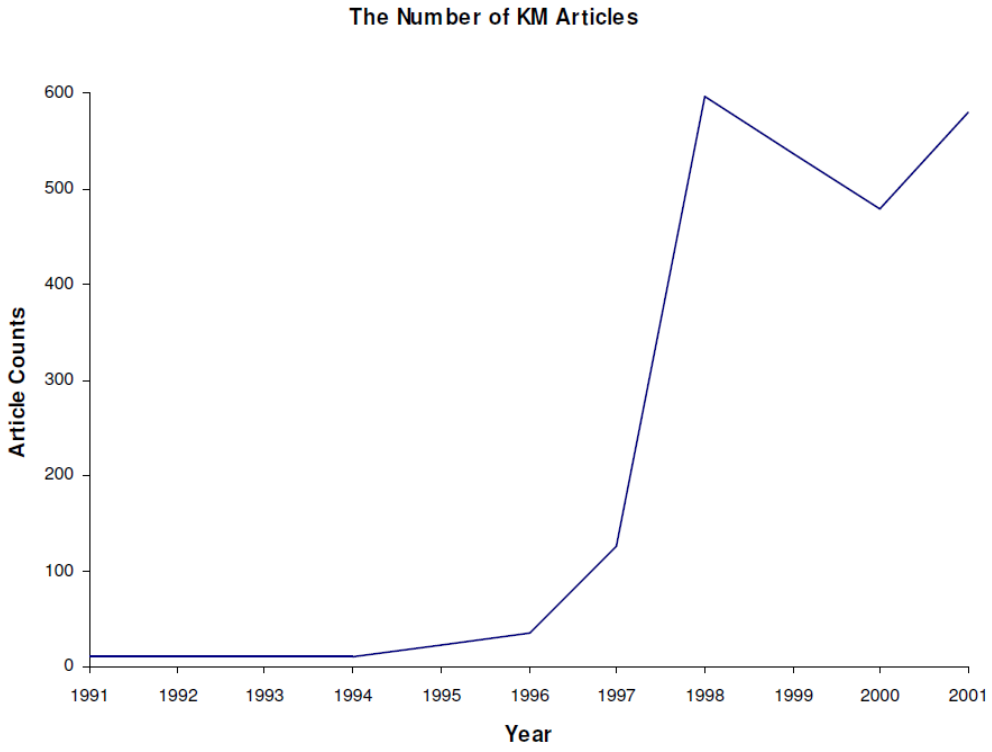

Figure 2.4. The number of knowledge management articles, 1991-2001 (Quintas 2005, p.10)

Nonaka and Takeuchi (1995, p.35) claim that one of the reasons why the knowledge management and new knowledge creation to be neglected up to now may be found at the strong orientation toward formalizing the existing knowledge. According to Quintas (2005), a number of drivers for knowledge management come together at our time. The author states that "we are at a juncture where limitations of information systems have been noted and the potentials for knowledge systems are yet to be

realized". Quintas (2005, p.15-19) states the major factors behind the recent surge in the industry to the knowledge management which justify the amount of research done, below:

- Company value has come to be increasingly generated from knowledge and intangible assets.
- Early resource strategies were heavily depended on downsizing the organization and outsourcing the knowledge. It was realized that the people are the main source of organizational knowledge.
- Rapidly growing and altering economy and markets demanded for continuous regeneration and development of organizational knowledge.
- The new competitive markets also require for innovation in products, processes and services in order for firms to survive. Organizations need to build their own knowledge bases increasingly and at the same time, create variety in them.
- It has become impossible for an organization to undertake all possible developments and to create knowledge capabilities across all aspects of operations within the complex and rapidly advancing nature of markets and technologies. Organizations must develop the ability to access and assimilate new knowledge from external sources.
- Tendency to use the information technologies assuming it would enable the seamless transfer from data processing to knowledge management caused dead-ends and this condition required step-change in knowledge management.

Davenport et al. (1998) admit that as the knowledge management is still developing, most of the related projects are common in many ways. The authors claim that all examples have required commitment from human and capital resources and explicitly concentrated on knowledge, on the contrary to information or data. In the business environment, Anumba et al. (2005, p.151) suggest that successful establishment of knowledge management initiatives are possible with well-defined strategies that requires dedicated effort from the top management.

Sheenan et al. (2005, p.52) put emphasis on the importance of the application of knowledge management systems. The authors state that while technological advances may offer some benefits, they are not designed to provide us with a complete solution. It is added by the authors that, in practice, most construction organizations focus on the needs of their people or processes first, and then seek for appropriate tools in these areas to facilitate a strong knowledge sharing environment.

In the following sections, the aspects of knowledge management are introduced in detail. First, the general approaches to knowledge management in the AEC industry are given. Second, the components of knowledge management systems and processes taking place in these systems are included. Following that, the common tools for supporting the knowledge management processes are put forward.

2.4.1. Knowledge Management Strategies

Anumba et al. (2005, p.151) introduce the definition which states that "a strategy is a detailed plan for achieving success in situations such as war, politics, business, industry or sport, or the skill of planning for such situations". Sheenan et al. (2005, p.51) suggest that the use of a good strategy in construction organizations is to generate informed decision-making by providing knowledgeable people with integrated information and data sources, as shown in Figure 2.5.

According to Anumba et al. (2005, p.151), strategies for the management of knowledge can be categorized as 'supply-driven' and 'demand-driven'. Supply-driven applications assume that the flow of knowledge and information within the organization is the focus of the studies of knowledge management. The authors suggest that this kind of strategies aim to increase and enhance the knowledge flow by capturing, codifying and transmitting knowledge. It is added that strong dependency on technological advances are often observed in supply-driven strategies. Anumba et al. (2005, p.151) state that demand-driven approaches are more concerned with users' perspectives and the emphasis is on their motivation and

attitude within the organization. These strategies utilize ways of encouraging knowledge sharing such as reward systems.

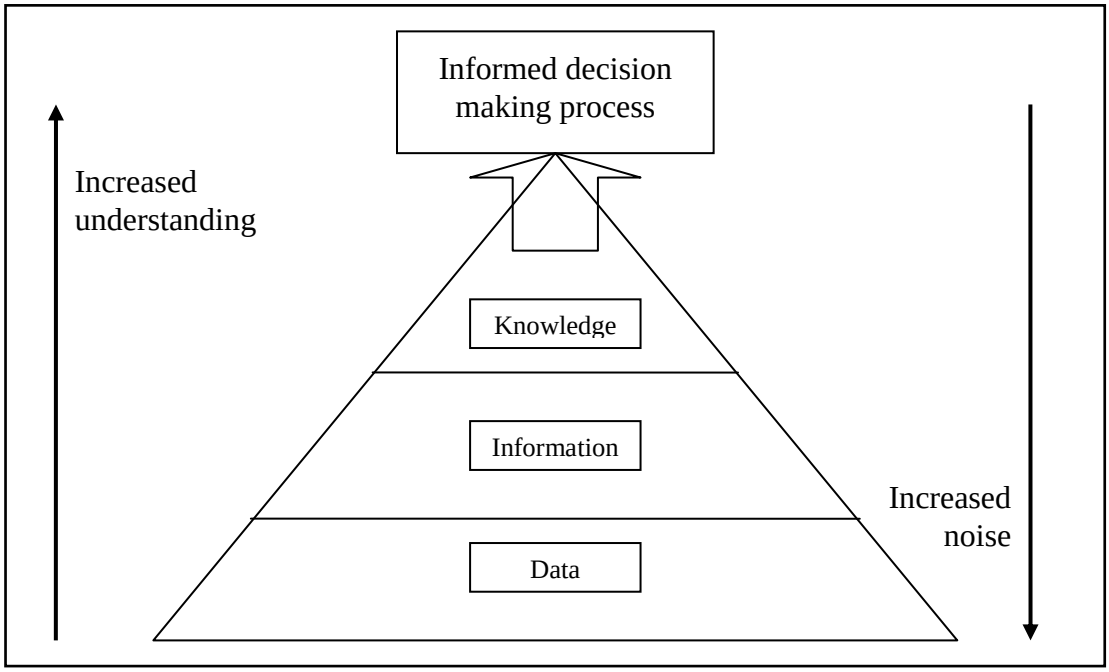

Figure 2.5. Knowledge support for decision-making (Sheenan et al., 2005, p.51)

Another categorization of knowledge management strategies is introduced by Carrillo and Chinowsky (2006). According to the authors, the organizations have accepted two different strategies to establish knowledge management: The first approach is information technology (IT)-centric strategy where the emphasis is on the use of IT tools to enable the capture, access and reuse of information and knowledge. In this type of strategy, electronic databases such as extranets and collaborative tools are often applied. The second approach is human resource management (HRM)-centric strategy where emphasis is on the establishment of means to motivate and trigger knowledge workers to develop, enhance, and use their knowledge in order to realize organizational goals.

Above the discussion about the strategies, Kamara et al. (2002) dictate that regardless of the emphasis, two key factors – "content" and "context" – determine

the success of knowledge management strategies. Content refers to knowledge that is to be managed. Context refers to the organizational setting for the application of knowledge, and includes culture and human dimensions of knowledge management.

2.4.2. Components of Knowledge Management

Sheenan et al. (2005, p.52) suggest that, concerning the tacit knowledge in people's heads or explicit knowledge in documents, any organization willing to establish a knowledge management system should relate initial projects to successful practices. For a better deliverance of knowledge management into practice, the authors claim that many organizations have considered it necessary to investigate knowledge management in specified terms such as: people, process and technology.

Bhatt (2001) puts emphasis on the fact that organizational knowledge is built through the unique patterns of interactions between technologies, techniques, and people. The author adds that the uniqueness of this interaction, which renders it very hard to be traded or imitated among organizations, enhances the value of this phenomenon even more. According to Bhatt (2001), the implication of the relationship between people, techniques and technology has profound effects on the knowledge management.

In the literature, people and culture of the organizations are considered as the social aspects of knowledge management and keys to successful implementation. As Nonaka and Takeuchi (1995, p.59) put forward, organizations cannot create knowledge without individuals. Sheenan et al. (2005, p.53) state that 80% of useful knowledge in the industry is tacit and cannot be recorded. The authors add that even though there is an abundance of experimental knowledge in construction industry, senior staff tends to leave or retire eventually and if not recorded, the tacit knowledge is lost for the organization. According to the authors, the key challenge is to know who knows what and to enable transfer of knowledge from key staff through the whole organization.

According to Sheenan et al. (2005, p.55), it is possible to implement a knowledge management system by focusing mainly on crucial processes. By embedding good knowledge-sharing practices into daily activities and making them a part of core business processes and implementing a knowledge network to share, the authors claim that satisfactory results can be observed. The authors present some tools like best practice documents, project reviews, communities of practice in order to have a successful application.

Technological advances are often seen as enablers at the background of several knowledge management initiatives. Though, many researchers point out the fact that they become a waste of resources and time unless chosen carefully. Sheenan et al. (2005, p.58) claim that construction organizations searching for technology solutions for knowledge management must identify clear areas where knowledge management could be enabled through technology.

2.4.3. Knowledge Management Cycle

In the literature, knowledge management accounts for a total of sub-processes where these processes may vary in what identities they have and what they include (Nonaka and Takeuchi, 1995; Carrillo et al., 2000; Bhatt, 2001; Yin et al., 2008), but as a whole, they cover the same activities. Bhatt (2001) defines knowledge management as a process of knowledge creation, validation, presentation, distribution, and application, as shown in Figure 2.6. The author claims that these five phases in knowledge management allow an organization to learn, reflect, and unlearn and relearn in order to build, maintain and replenish the core-competencies.

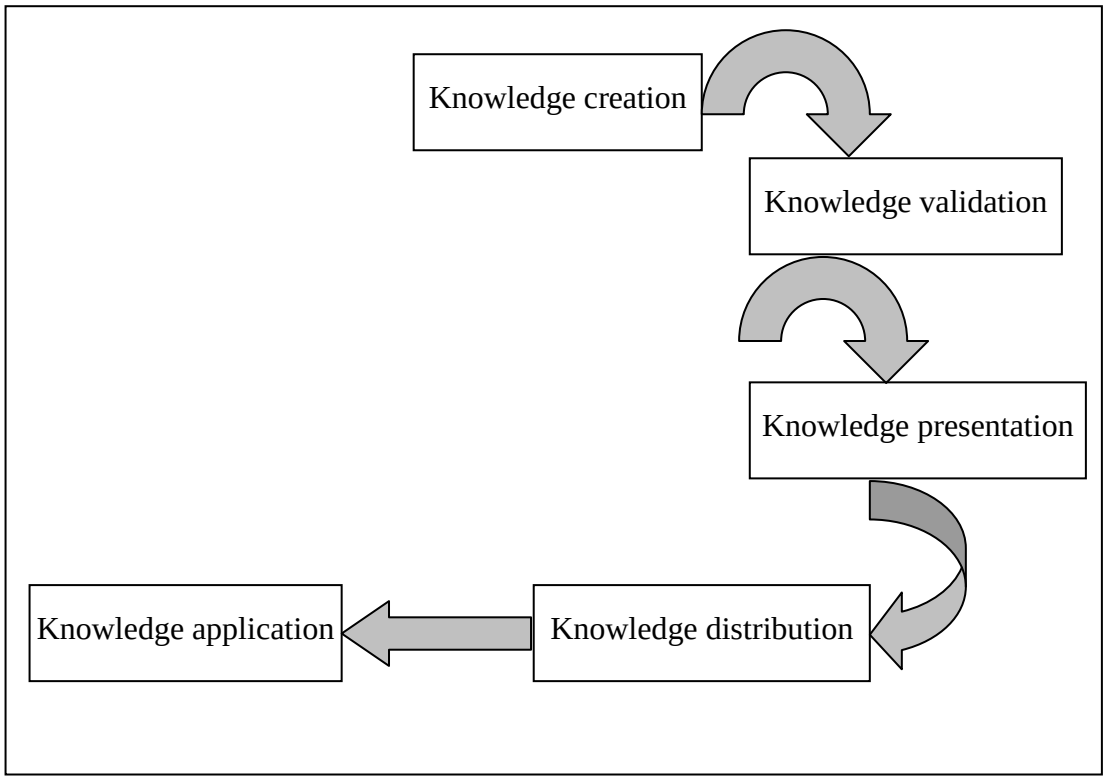

Figure 2.6. Knowledge management process activities (Bhatt, 2001)

2.4.3.1. Knowledge Creation

Nonaka and Takeuchi (1995, p.59) state knowledge is created only by individuals and an organization supports these creative individuals by providing them with contexts to generate knowledge. According to the authors, tacit knowledge held by individuals is the basis of knowledge creation. Bhatt (2001) describes knowledge creation as an emergent process which is realized by motivation, inspiration, experimentation and pure chance.

Even though knowledge creation is the first step of the whole knowledge management process, Bhatt (2001) suggests that an organization does not necessarily need to create knowledge from scratch. The author claims that by several methods, like reconfiguring existing knowledge along with imitation, substitution and replication, organizations may have a fresh start.

2.4.3.2. Knowledge Validation

Bhatt (2001) defines this stage as the ability of evaluating the knowledge for the existing organizational environment. According to the author, this stage is "a painstaking process of continually monitoring, testing and refining the knowledge base to suit the existing realities". Nonaka and Takeuchi (1995, p.86) state that individuals seem to be fulfilling this duty unconsciously throughout the entire process, but it is the organization's duty to justify the created knowledge in a more explicit way. The authors emphasize on the fact that this justification can either include quantitative criteria such as cost, profit margin etc. and qualitative such as aesthetics, romanticism etc.

2.4.3.3. Knowledge Presentation

In the definition of Bhatt (2001), knowledge presentation implies the ways of displaying knowledge to the members of the organization, as Nonaka and Takeuchi (1995, p.87) describe, in a tangible or concrete manner. Nonaka and Takeuchi (1995, p.87) suggest that this can be considered as a prototype in the case of a new product development process, similar to an architect building a mock-up before facilitating further development. According to the authors, this is achieved by combining newly created explicit knowledge with existing explicit knowledge.

2.4.3.4. Knowledge Distribution

Bhatt (2001) states organizations need to share and distribute knowledge before utilizing it at an organizational level. According to Nonaka and Takeuchi (1995, p.89), for this stage to function, each organizational unit must be capable of taking the knowledge from somewhere else and applying it comfortably. The authors also claim that when knowledge is distributed, the cycle of knowledge creation starts again with this new kind of knowledge. Bhatt (2001) emphasizes on the distribution of knowledge by stating that applications such as e-mail, intranet, bulletin board, and newsgroup support the distribution of knowledge throughout the organization and

enable organizational members to debate, discuss, and interpret information through multiple perspectives.

2.4.3.5. Knowledge Application

Bhatt (2001) suggests that organizational knowledge needs to be utilized in a company's products, processes, and services. The author emphasizes that unless organization finds it easy to locate the right kind of knowledge in the right form, the firm may struggle to maintain its competitive advantage. The author finally adds that innovation and creativity are important factors of the present competitive arena; an organization should be capable to find the right kind of knowledge in the right form as soon as possible from the organization.

2.4.4. Techniques and Technological Tools for Knowledge Management

Al-Ghassani et al. (2005, p.83) explain that knowledge management is not solely consisting of information technology (IT) tools. The authors state that knowledge management makes use of both IT and non-IT tools in order to support sub-processes like locating, sharing and modifying knowledge. Bhatt (2001) informs that IT can be used to filter and categorize information, but in the dynamic business environment, it is only through people that information can be interpreted into valuable knowledge.

According to Al-Ghassani et al. (2005, p.83), one of the common problems for organizations is identifying appropriate tools among a wide range of similar products in the market. Even though, the authors state that selecting appropriate tools is important, it is also added that, the organization must clearly identify the business problems and define organizational goals. A general comparison of social techniques and technological tools are presented in Table 2.1.

Table 2.1. Knowledge management techniques and tools (Al-Ghasani et al. 2005, p.84)

Knowledge Management Tools	
Social Techniques	Technological Tools
▪ Require strategies for learning ▪ More involvement of people ▪ Affordable to most organizations ▪ Easy to implement and maintain ▪ More focus on tacit knowledge	▪ Require IT infrastructure ▪ Require IT skills ▪ Expensive to acquire and maintain ▪ Sophisticated implementation ▪ More focus on explicit knowledge

2.4.4.1. Social Techniques

Knowledge management techniques are described as non-IT tools that do not require technology to support them and exist in several forms. (Al-Ghassani et al. 2005, p.84). The authors claim that knowledge management techniques are easy to implement and maintain as they include familiar features to individuals. Though, as the involvement of people is crucial for these techniques, some general strategies about learning and knowledge should be suggested first in order to enhance the effects. Al-Ghassani et al. (2005, p.84) suggest that these techniques are essential in knowledge management as their focus on retaining and increasing organizational tacit knowledge which is the key asset in whole process. Some examples of techniques are given below.

After action review is a method of bettering procedures learn while they are being performed. On the contrary to other review and evaluation methods, the after action reviews are conducted before a problem is repeated several times. The objective is to learn as you perform and observe the reasons of why a problem is occurred, realize the lessons learned and contribute as much as possible into performance process immediately. The after action reviews work best if they are focused on the few most critical issues, are done immediately after the action, are inclusive of the whole

group, are in accordance with a structured process and are leading back to action quickly. (Baird et al. 2000, p.187)

Benchmarking is the process of comparing the cost, cycle time, productivity, or quality of a specific process or method to another and the result is often a business case for having necessary modifications in order to make improvements in the related activities (Wikipedia, 2009, Benchmarking). According to Emmitt (2007), benchmarking is a method of collecting data for project evaluations by making comparisons on a number of levels.

Brainstorming is a process of generating ideas in large quantities which propose different and unusual solutions focusing on a specific problem. This usually involves a group of people who intentionally thinking out loud in order to come up with an adequate result. The ideas are freely shared without interruption and analyzed only after the session is over. Brainstorming aids organizations in problem solving and in creating new knowledge from existing knowledge. (Al-Ghassani et al. 2005, p.85)

Communities of practices are groups of people from different backgrounds and skills who come together to accomplish specific goals. Different from teams and tasks forces, Al-Ghassani et al. (2005, p.85) claim that the reason of existence for them is a common sense of purpose and a real need to know what each other knows. According to the authors, communities of practices are generally numerous in a company and most people usually perform in one or more.

Face-to-face interaction is a traditional and basic method for sharing tacit knowledge between employees of an organization. It is generally in an informal approach though is very effective. According to Al-Ghassani et al. (2005, p.85), face-to-face interaction supports the organization's memory, developing trust and facilitate effective learning. The authors claim that this provides an environment within an organization where employees consider the firm as a human community capable of providing diverse meaning to knowledge.

A **learning history** is a document that tells an organization its own story (Roth and Kleiner, 1998). The document is aimed to create better conversations that capture and provide an organization with learning. In generating a learning history, it is considered important to stay true to the data, stay true to the story of the data and to be aiming to the audience. Steps for building a learning history are: planning, reflective interviews, distillation (refining), writing, validation and dissemination (Roth and Kleiner, 1998).

Post-project reviews are considered as an important component of quality-management systems. Projects are evaluated at the final phase in order to realize whether projects goals are accomplished or not. The post-projects reviews include comments and information from major participants of the project and are usually conducted as a meeting or a series of meetings. According to Emmitt (2007, p.153), this application provides valuable knowledge for possible future projects, which draw on and adapt the information, knowledge and experiences created during previous projects.

Recruitment is an easy way to buy-in knowledge (Al-Ghassani et al. 2005, p.86). This technique is especially useful for acquiring external tacit knowledge of experts. The authors claim that, recruitment also facilitates learning among new and old members of an organization in both formally and informal ways so that some knowledge is captured and retained even if the individual leaves the organization. According to Al-Ghassani et al. (2005, p.86), some organizations try to codify the recruited person's knowledge that is of critical importance to their business.

Training supports improving staff skills and therefore this technique increases knowledge. According to Al-Ghassani et al. (2005, p.86), the implementation depends on strategies developed by the organization to facilitate the continuous learning and updating for employees. Training is generally conducting in a formal format and can be internal, where senior staff train junior employees within the organization, or external, where employees are provided with courses managed by professionals.

2.4.4.2. Technological Tools

According to Bhatt (2001), technological tools are only enablers to organize data and information and still human interpretation is needed to generate knowledge. Other researchers also question the importance of knowledge management technologies, but many organizations tend to rely on them in order to implement knowledge management systems. As Davenport and Prusak (1998) observe, establishing knowledge management technologies demands half of the effort needed to prepare people and organizational culture.

Al-Ghassani et al. (2005, p.86) consider knowledge management technologies as a combination of hardware and software technologies. According to the authors, hardware technologies build the platform (computers, workstations, servers, networks etc.) for the software technologies to perform. The authors also add that the large number of retailers that provide knowledge management solutions makes it difficult to choose appropriate applications. Carrillo et al. (2000) categorize the software technologies as shown in Figure 2.7.

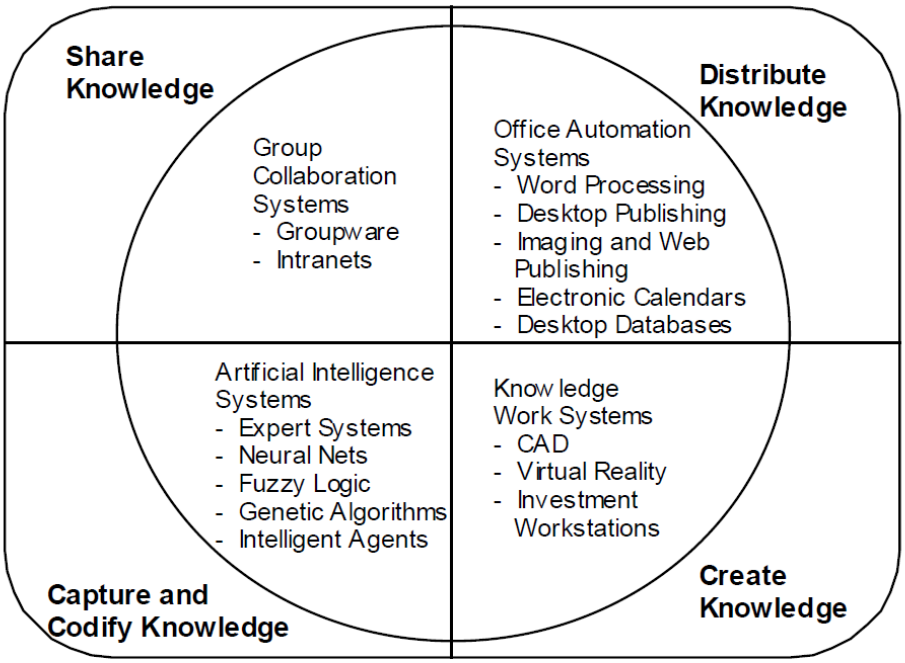

Figure 2.7. Systems for knowledge management (Carrillo et al., 2000)

Al-Ghassani et al. (2005, p.88-89) provide some of the examples of software technologies below. Though, the authors add that no software technology alone can perform as a complete solution to knowledge management.

Data and text mining is a technology for identifying and locating meaningful knowledge from masses of data or text (Al-Ghassani et al. 2005, p.88). The process of data/text mining identifies meaningful patterns and associations of data in one or more large databases. According to Al-Ghassani et al. (2005, p.88), this approach is very useful for recognizing hidden relationships between data and hence creating new knowledge.

Groupware is a software product that supports communication and sharing information between employees. It enables employees to perform work efficiently and effectively, and to facilitate group decision-making using IT (Al-Ghassani et al. 2005, p.88). Groupware includes email, instant messaging, discussion areas, file area or document repository, information management tools and search facilities.

Intranet is an internal organizational internet that is restricted to outside access by special security tools, while extranet is an intranet with limited access to outsiders, enabling them to share certain knowledge on the intranet. Al-Ghassani et al. (2005, p.89) consider this technology very useful for making organizational knowledge available to geographically dispersed staff members.

Knowledge bases are repositories that store knowledge about one or more topics in a succinct and organized manner. They include knowledge that can be found in a book, a collection of books, websites or human knowledge. (Al-Ghassani et al. 2005, p.89)

Taxonomy is a collection of definition of terms and the relationships between these terms that used commonly in an organization. Ontologies define the terms and their relationships and they also support deep representation of each of the terms as well as domain rules that govern the operations allowed with the concepts in the ontology (Al-Ghassani et al. 2005, p.89).

2.5. Architectural Knowledge and Management

Architectural process is heavily dependent on information about what is expected and how it can be accomplished. According to Kalay (2006), architectural design is an information-centric activity where current conditions of a being is analyzed and plans for new and better conditions of being are devised. Zisko-Aksamija (2008, p.216) defines architectural design as a process, based on tacit knowledge, gained through education and experience. The author notes that architects and engineers also use explicit knowledge for the design, such as materials databases, building codes and specifications, manufacturer's catalogs, etc. In this context, the transmission between tacit and explicit knowledge in architectural design is inevitable and essential.

Duerk (1993, p.8) claims that the process of information management in design process is vital for making the right kind of information available at the right stage of the process and for giving the best possible decisions in the building design. Emmitt (2007, p.2) disagrees with the 'stereotypical view' implying that creative designers should not be subjected to managerial control. The author claims that the majority of architects and designers value the sensitive and appropriate management.

Yin et al. (2008) champion the organization of the knowledge flow in organizations as the main component of management. The authors claim that the difficulty in facilitating this flow originates from the product uniqueness and on-site production in the industry, ad-hoc organization of the project teams accompanied with high personnel turn-over. Zisko-Aksamija (2008, p.216-217) points out another dimension of the problems claiming that the architects and engineers are overloaded with the amount of information that leads the contemporary design from physical, structural, mechanical systems to material selection and sustainable design. The author states that the complexity of projects and the multi-disciplinary nature of buildings constructed today demand fundamental changes in the representation of designs, exchange of information, construction planning and knowledge management.

Representation methods of architectural knowledge are the products of a historical development. Zisko-Aksamija (2008, p.213) provides a brief summary of this development: Greek architects described their designs orally, and architectural models were first utilized at 725 BC at Perochora. Medieval master builders used geometric plan drawings in order to explain their designs. The discovery of linear perspective by Brunelleschi in 1425 provided spatial organization in representation methods for architectural design. During the 18th and 19th centuries, Ecole des Beaux Art described buildings as geometrical objects by using plans, sections and elevations in Cartesian system. The technological advancements in 20th century allowed for new tools and representation methods, such as CAD systems, three-dimensional modeling and building performance simulations. These advances suggest that digital technologies indicate a major turning point in the history of architectural drawing and representation.

At this point, one must realize that early development of knowledge management tools have been focused mainly on the information technologies and communication systems. According to Zisko-Aksamija (2008, p.221), the affect of advances have greatly improved the connection between the agents, but the design process has remained unchanged. The following developments have brought the model-based design where modeling is based on parametric components, but the documentation process uses traditional methods where the representation of design is achieved by geometrical orthogonal drawings and floor plan.

According to Kalay (2006) information technology can become a revolutionary force for the design activity. The author states that information technology has made the production, manipulation and dissemination of information cheap and easy. But the author adds that this force may become ‘revolutionary’ only when its effects transform the current hierarchical design process into a network of design, manufacturing, marketing, and management organizations. The author implies that it can emphasize and encourage the integration of distinct standardized products and services into a unique whole and facilitating mass-customization without substituting quality for cost.

The multi-disciplinary nature of AEC industry and the unique characteristics of the end-products have hindered the developments in the information and knowledge management aspects of the industry. The architectural design process possesses the same attributes and understanding the vast aspects of architectural design is one of the main challenges in attempt to explicitly manage the design process.

2.5.1. Architectural Design Process

Kalay (2005, p.13) suggests that the architectural design as known today is a relatively recent phenomenon and describes it as a relationship between two paradigms; problem solving, where the designer analyzes problems and generates solutions, and design as puzzle making, where design is seen as discovery of parts are meant to be synthesized into a meaningful whole. Lawson (2006) explains design as "a negotiation between the problem and solution through the three activities of analysis, synthesis and evaluation".

The nature of architectural design is a subjective matter that is contingent on many factors such as the type of project, the project site, the client and the architect. Many researchers agree that architectural process is the search for the best fitted solution for the given design problem which satisfies the client's needs, environmental expectations, and architectural standards. Zisko-Aksamija (2008, p.223) claims that there is not a single formula to transform the performance requirements into an organizational assembly of building elements. One of the reasons for that is given by Lawson (2006) who suggests that problems and solutions in architectural design overlap each other in an unpredictable way. It is suggested by the author that design process is an iterative activity and achieved solutions may generate new design problems until adequate requirements are satisfied. This cyclical practice is presented as the Marcus - Maver map of the design process by Lawson (2006, p.37) in Figure 2.8.

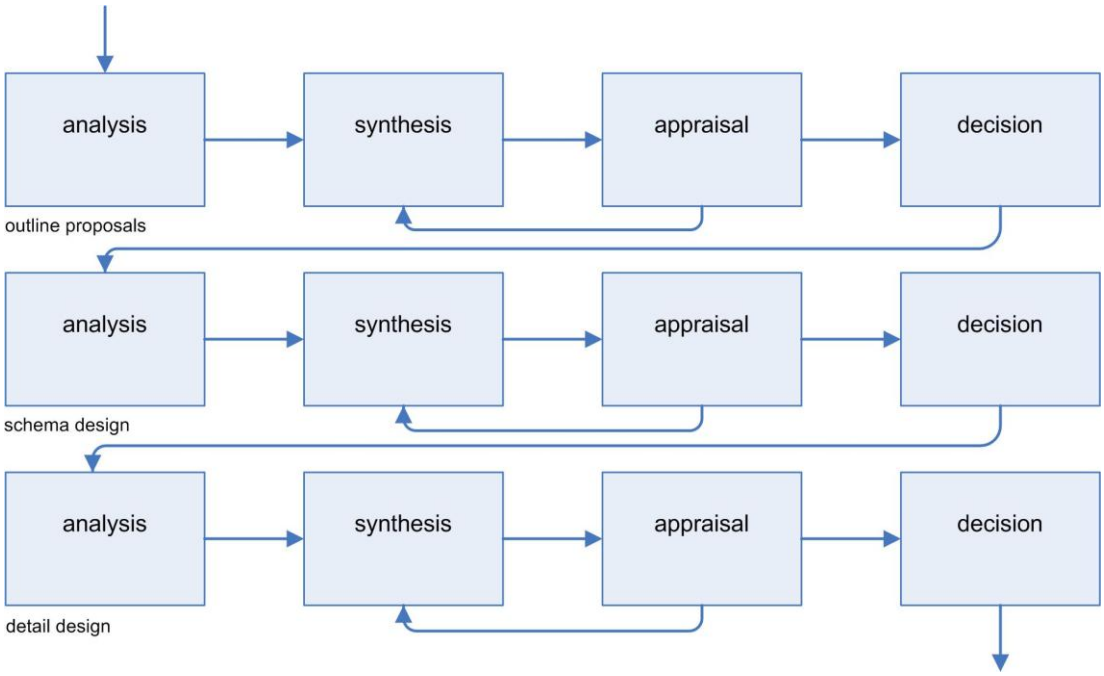

Figure 2.8. The Marcus – Mayer map of design process (Lawson, 2006, p.37)

According to Zisko-Aksamija (2008, p.223), the initial stage of architectural design is the collection of information such as set of spatial, functional, economical requirements, and the information about the conditions on the site. One can add "client" to this set. These are listed as follows and also shown in Figure 2.9:

- Site : topography, orientation, wind, resources, climate
- Type of function : industrial, commercial, residential, institutional
- Budget : low, medium, high
- Users and needs : types, personalities, habits, number of users
- Form : style, culture, aesthetics
- Structure : building location, size
- Materials : availability, energy-efficiency

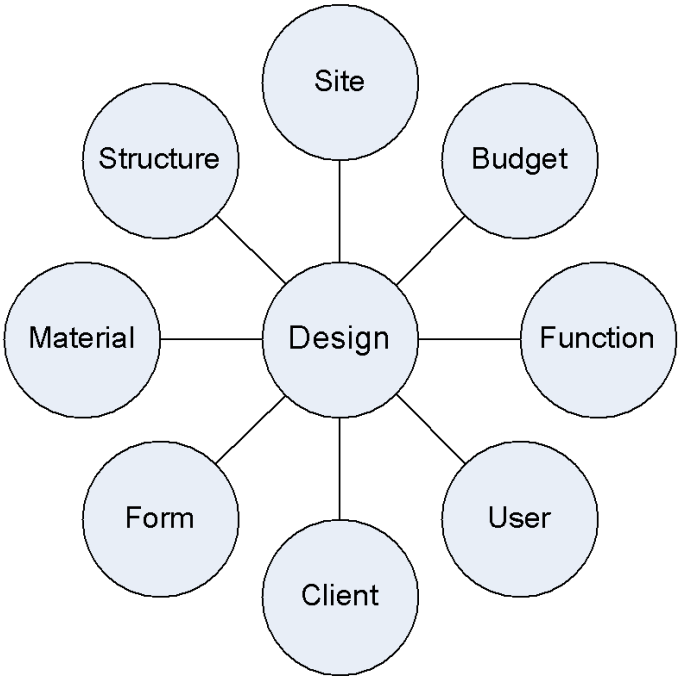

Figure 2.9. Factors affecting architectural design process (adopted from Zisko-Aksamija 2008, p.224)

Zunde and Bougdah (2006, p.89) consider recording all the related material in an organized and accessible way as a must in architectural design. The authors claim that the reflection of this data leads to determination of internal factors on the design such as constraints on budget and time, codes and regulations and client requests. In this respect, the ideas and experience of individuals in a design team also continuously interact with the constraints mentioned above until a satisfactory and better design solution is accomplished.

Collecting data and information about the existing condition of a subject matter is imperative to define the constraints and possible solutions for a design problem. Duerk (1993, p.11) emphasizes on the fact that ability of synthesize and analyze skillfully is necessary for outlining the future state, developing the goals and concepts. According to the author, as the design process moves forward, the need for analysis shifts through the need of synthesis (see Figure 2.10).

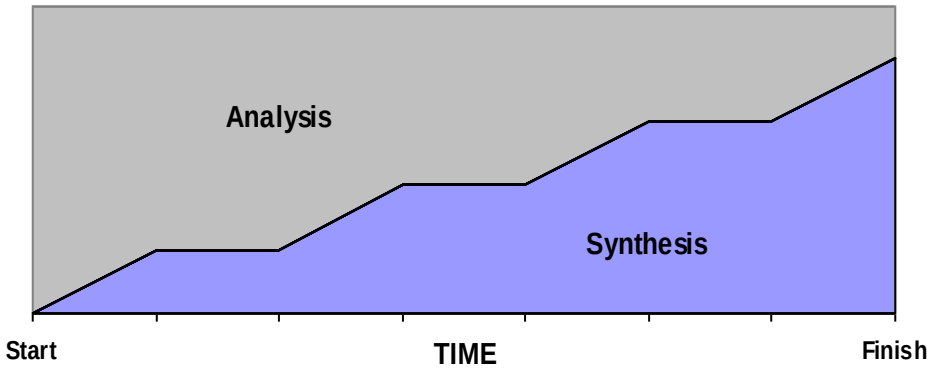

Figure 2.10. Interdependence of analysis and synthesis (Duerk, 1993, p.11)

Zisko-Aksamija (2008, p.248) states buildings are the largest products of human effort and creating them requires significant amount of information and expertise from numerous domains for successful design, construction and operation. It is therefore very important to provide a general framework which illustrates actors and relationships in an AEC project in order to illustrate how the information flows through, as shown in Figure 2.11. Zunde and Bougdah (2006, p.87) emphasize on understanding the fact that finding the optimum solution to a design problem is a systematic process.

In the literature, there are several methods of increasing, if not guaranteeing, the possibility of achieving a better design solution. These methods in general are meant to enable the designer to clearly see the external and internal constraints of a problem. In Duerk's study (1993, p.12), several frameworks for organizing design data are introduced. First framework developed by Pena in 1987 divides design issues into four categories: form, function, economy, and time. Second framework developed by Palmer in 1981 categorizes design issues as such: human factors, physical factors, and external factors. Third framework developed by White in 1972 focuses on building up check lists for facts to be found out about the existing context and utilized the following categories: similar projects, client, financial, codes, planning by related organizations, function, site, climate-growth, and change. Duerk (1993, p.12) proposes the use of design issues as the categories for organizing design information with facts, values, goals, performance requirements, and concepts.

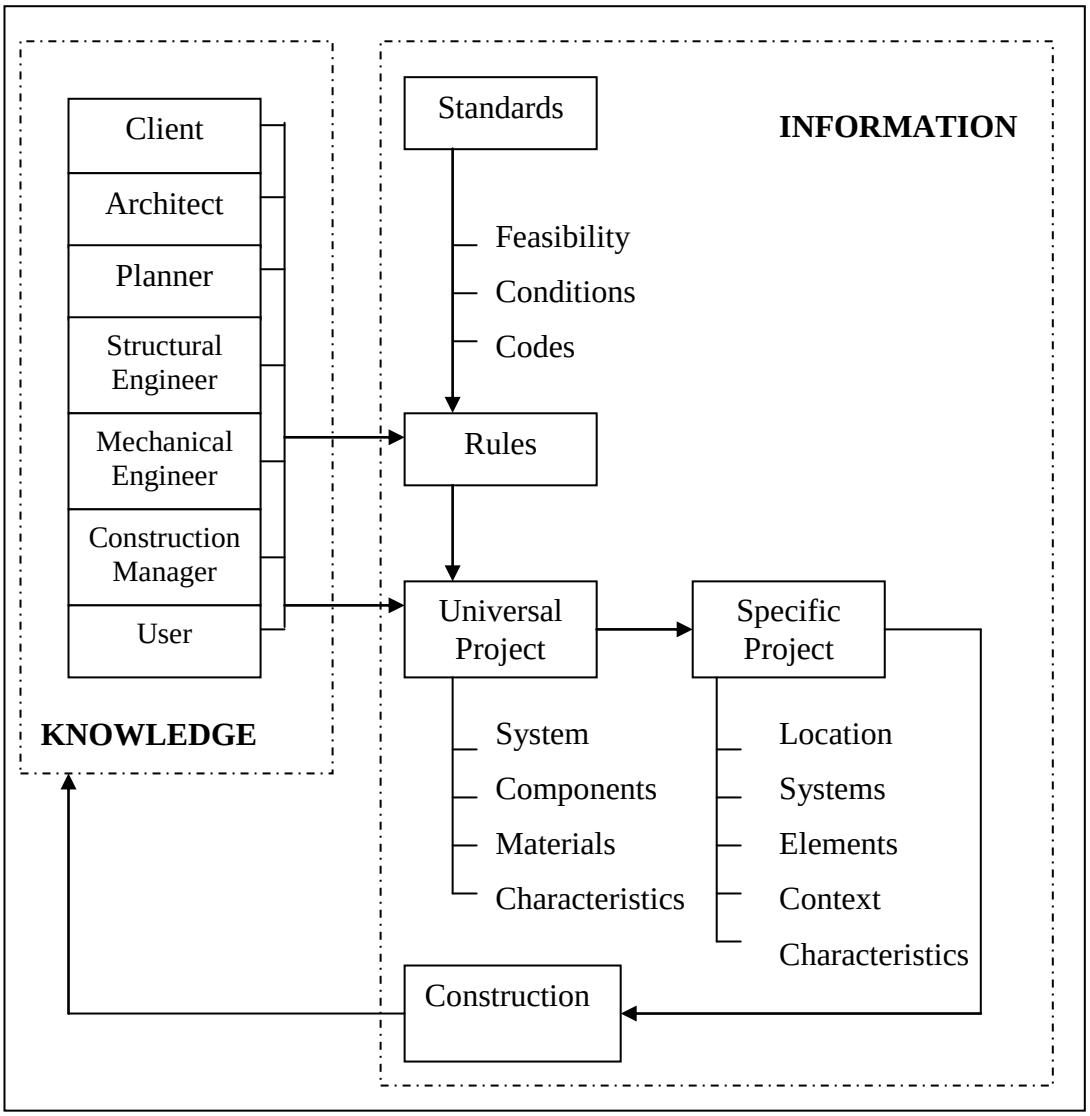

Figure 2.11. General knowledge management framework in construction industry, adopted from Zisko-Aksamija (2008, p.247)

American Institute of Architects (AIA) provides a thorough framework for the design procedure which comprises five phases: Schematic design, design development, construction documents, bidding, and construction administration (Cummings, 2008). In a different version, pre-design and post-design phases are also included as the initial and final phases (Duerk 1993, p.15). The phases of suggested framework are given below:

- *Pre-design stage* includes activities like programming and feasibility research. At this stage, master plans and prototypes are investigated.

- *Schematic design phase* includes developing the program objectives, learning codes and regulations, investigating the site, developing concept design proposals and developing budget estimates for the project. The end products of this phase are site plan, floor plans, schematic massing models, and general cost estimates.
- *Design development phase* includes refining the project parameters, developing the project design (including material selection), performing a detailed cost estimate and developing a technical specifications outline. The end products of this phase are site plan, floor plans, roof plans, exterior elevations, building sections and cross-sections, built-in elements plans and elevations, structural systems schematics, mechanical system schematics, detailed cost estimates.
- *Construction documents phase* includes developing construction documents package, where previously generated documents are developed as a package of construction requirements, for installation by the contractor, developing complete technical specifications, updating detailed cost estimate, and developing bidding documents. The end products of this phase are site plan, floor plans, reflected ceiling plans, roof plans, exterior elevations, building sections and cross-sections, wall sections, weatherproofing details, detailed plans and interior elevations, door and window schedule and details, interior finish schedule and details, built-in furnishing details, and structural, mechanical, plumbing and electrical plans and details.
- *Bid phase* includes assisting in developing a list of bidders, administering bidding process, and evaluating bids. The end products are contractor selection and construction cost pricing.
- *Construction administration phase* includes assisting in developing and awarding final contract, reviewing contractor submissions, performing periodic site inspections and administering contract. At the end of this phase, the building design and construction process is finalized.
- *Post-design stage* includes activities like post-occupancy evaluation, developing users' manuals and performing evaluation researches.

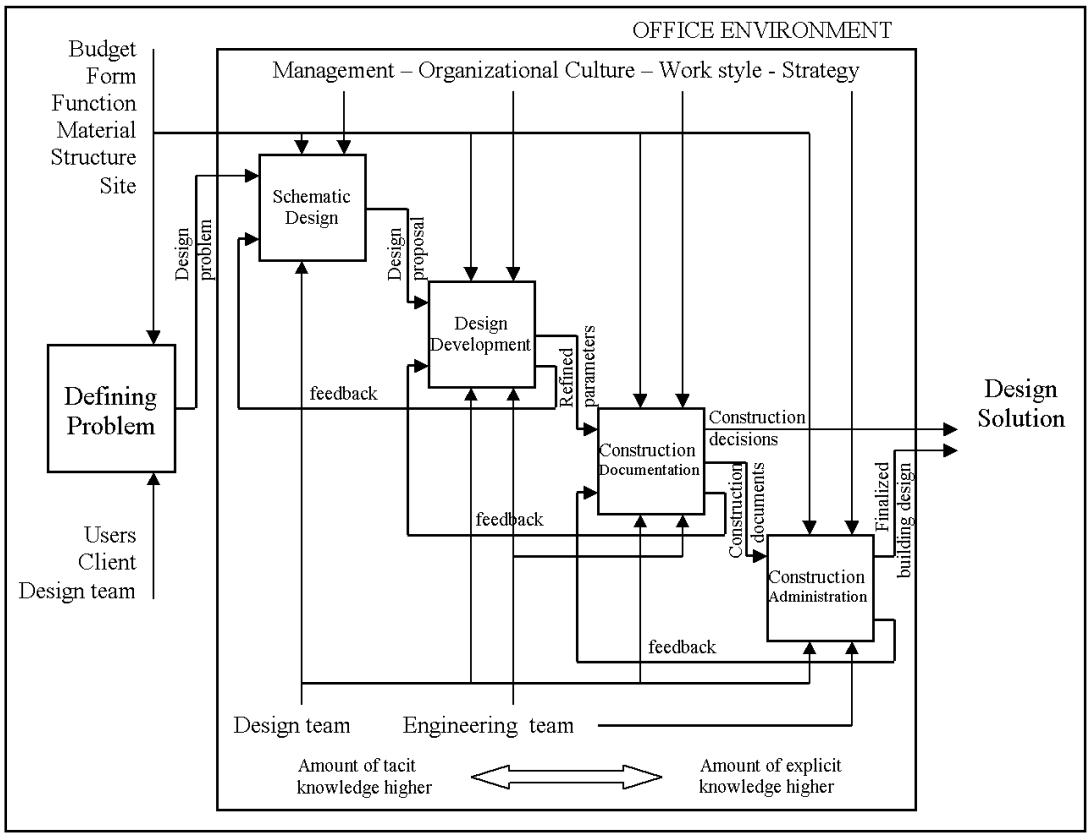

Figure 2.12. Process model for architectural design activity

Considering each design problem is unique on its own; it is wise to claim that different approaches for collecting, analyzing and interpreting design information are required for different projects in order to end up with a solid solution. The subjectivity of project information and the amount of tacit knowledge in the architectural process are challenges against the application of knowledge management. Also, the seamless transfer of necessary knowledge to other parties requires a great deal of diligent organization. A process model of architectural design activity is shown in Figure 2.12. It is apparent that architectural organizations can benefit from systematic approaches towards knowledge considering the competitive environment, tight project schedules, and the overall subjectivity which requires flexible organizations with quick decision making ability.

2.5.2. Managing Architectural Organizations

Architectural design offices are creative and dynamic places. Thompson (1999, p.29) and Emmitt (2007, p.171) state that design offices need to possess abilities such as management, office organization, market orientation in addition to designing and technical skills in order to conduct successful businesses. The projects and the profitability of the business are significantly affected by the managerial structure of the firm and the organizational culture that develops within the office (Emmitt 2007, p.171). Social life of an architectural office is another important aspect which is supposed to provide the best possible environment for people to interact, create, share knowledge and contribute to projects without excessive barriers from poor working conditions.

Thompson (1999, p.29) claims that many architectural practices start as singular architect establishment. Consequently, the majority of architectural practices are very small, a characteristic of other professional service firms such as accountants and lawyers. Demonstrated in Emmitt (2007, p.171), surveys of architects in the UK and in other countries have shown that the general view of the architectural profession by size has remained unchanged over the years. According to the results, approximately 70% of offices are considered as ‘very small’ (1-5 architects), 15% in the small category (6-10 architects) and the remaining 15% are in the large category (more than 11 architects). Also, it is shown that around half of all architectural practices are conducted by a sole principal and less common forms of businesses are public companies and group partnerships and cooperatives.

According to the culture and size of the architectural offices, different organizational settings can be observed. Thompson (1999, p.38) points out the fact that practice of architecture is also a business and an efficient organization is needed for the maximum output from all employees. The author states that if the organizational framework is properly set up, then everyone is aware of the role they have and the communication can be perceived in a more systematic manner.

Thompson (1999, p.38) suggests two general organizational framework types. The first and simplest framework is a shallow one in which everyone is answerable to a single person or principal. A secondary and deeper framework is needed as the size expands in which project or group leaders are introduced and the responsibilities are shared. The author also suggests further variation as a mix of both frameworks where the principal controls some people working on their own, as well as a number of project leaders, who control further groups of people, as shown in Figure 2.13.

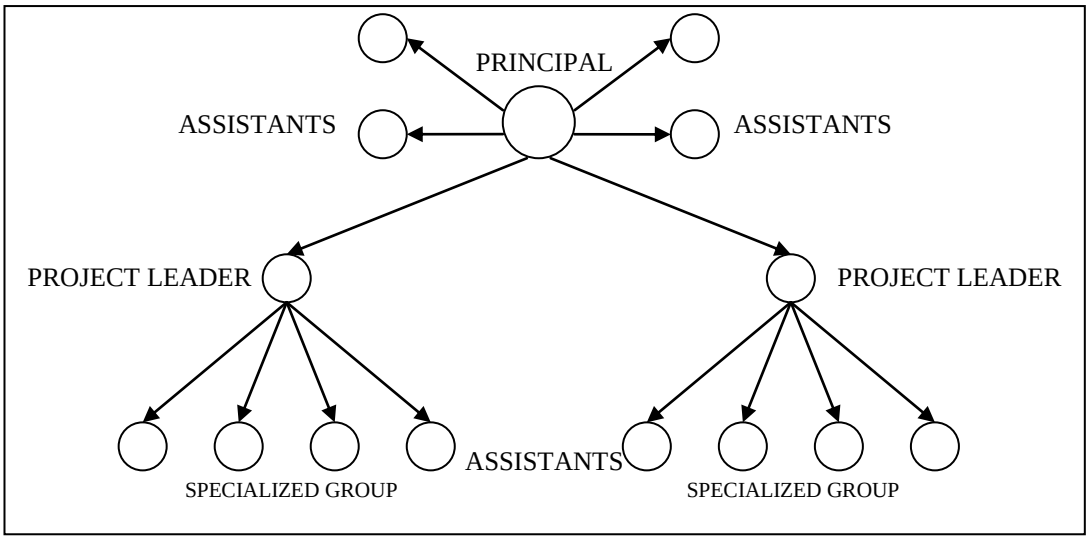

Figure 2.13. Mixed organizational framework, adopted from Thompson (1999, p.39)

Emmitt (2007, p.173) includes claims stating that the task of managing design organizations is different from managing other types of business due to the special rules associated with the creative process. The author partially agrees with those and also adds that design organizations have a number of characteristics that set them apart from other professional service firms: Architectural offices provide a service (market and client orientation), are regulated by professional bodies (regulations and codes of conduct), and are creative (solutions to unique problems) and are dependent on one market sector: construction (economy).

According to Emmitt (2007, p.182), architectural offices tend to differentiate according to their stance against the market and client requirements. As seen in Figure 2.14, the categorization consists of strong delivery, service and idea firms.

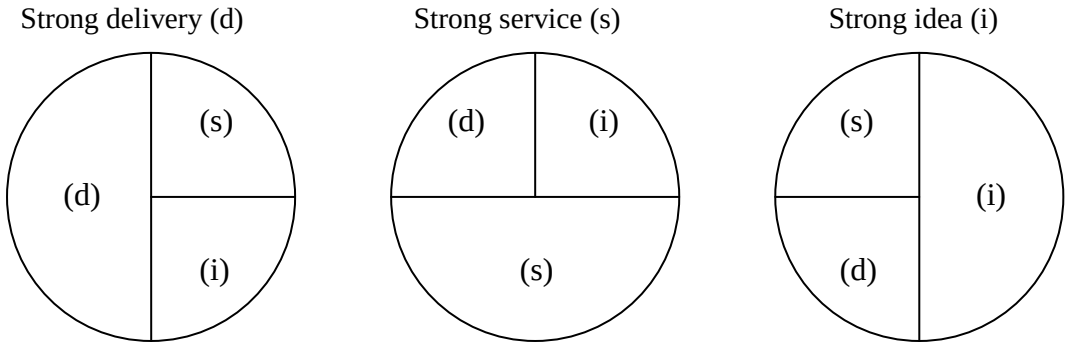

Figure 2.14. Organizational typologies (Emmitt 2007, p.183)

Strong delivery firm is organized for efficiency, relies on standard design solutions and has a formal structure and a relatively stable working environment. This firm tends to specialize in a limited range of building types. *Strong service firm* is organized for service and tailors its services to the specific needs to its clients. Individual and creative solutions are favored over standard responses, and greater client involvement in the project is encouraged. *Strong idea firm* is organized for innovation and seeks to provide innovative solutions to unique problems. It has a flexible, informal structure and a highly changeable environment. Standard design solutions are rarely considered because clients employ the firm for a unique project.

2.5.3. Communication in Design Process

"Coordination among the participants in the design process is facilitated by communication – a means for sharing information among individuals" according to the study of Kalay (2005, p.83). According to the author, communication enables architects, engineers, contractors, clients, and other participants in the design process to share information in order to consider, analyze, debate merits of this information and take necessary actions in an organized manner. Emmitt (2007, p.43) leverages

effective communication as one of the key factors of success in realizing project objectives as it strengthens the relationship between the main actors. The author adds that this allows healthy decision making in the process, especially in the critical early stages where the majority of opportunities are generated and the risks are minimized.

Kalay (2005, p.87-98) illustrates this interaction in three stages such as encoding, representation and decoding. According to the author, any message (e.g. design idea) must be converted into words or images by the sender (e.g. architect) to fit the medium in which the representation (e.g. scaled drawings) takes place. The author claims that representation alters the information, compressing it through a process known as abstraction which makes the proper decoding of this message dependant on the ability of the receiving party (e.g. client) and the shared knowledge between both parties (see Figure 2.15).

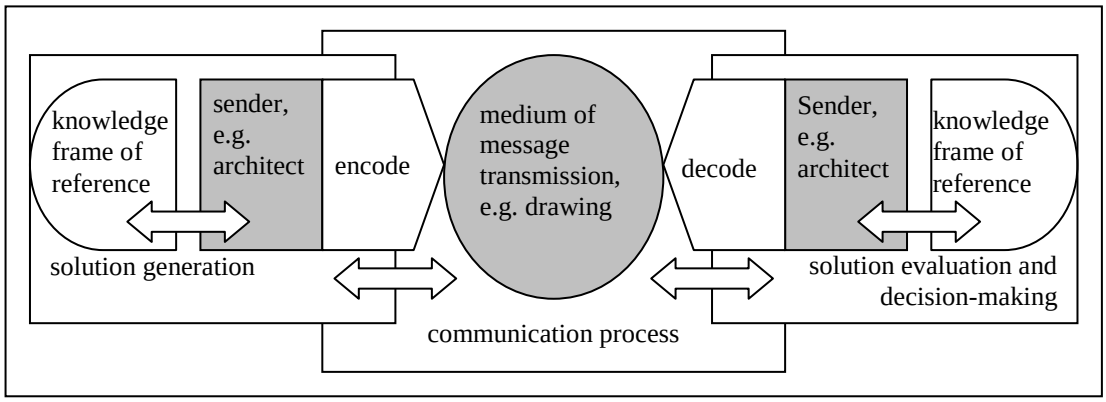

Figure 2.15. Communication in design process (Moum, 2006)

The initial point of communication in architectural design process is when the architect begins to transfer the possible design solutions in his mind to another medium. Lawson (2005) states that in order to reach to the integrative design solutions, the architect tries to keep many things in his mind at once in the intense periods of very rapid mental activity. The author relates this condition to designers' normally using a very rapid and flexible method of representation, sketching and he

adds that some methods of representing such as CAD tools are too slow to create the "conversation with the drawing".

Moum (2006) investigates the interaction of communication at different levels of an organization. According to the author, actions and communication in the architectural design process take places in the suggested three levels called the micro-, meso- and macro-level. The author explains these levels as the micro-level focuses on individual and cognitive processes, for instance the architect's individual development of design solutions. The meso-level covers the mechanisms and processes within a specific group such as the interaction between the architect and his design team. The macro-level is the overall set that the architectural business environment where the office, client and consultants cooperate (see Figure 2.16).

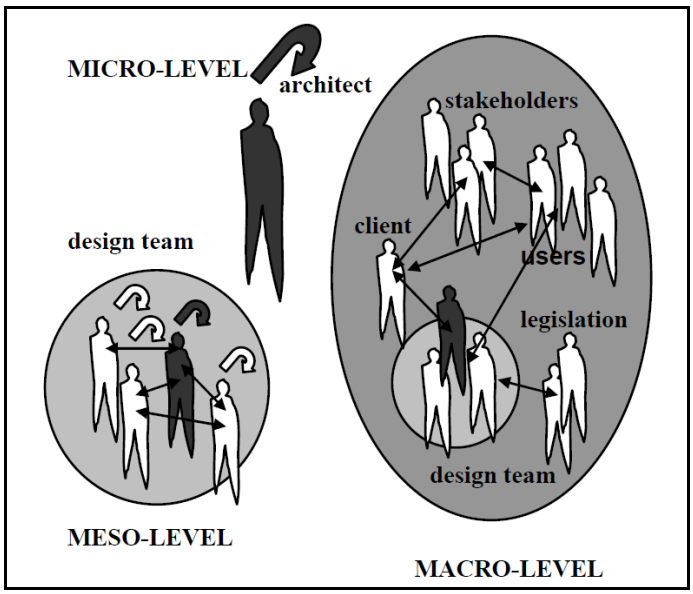

Figure 2.16. Hierarchical levels in architectural design (Moum, 2006)

Architectural offices in many projects take the responsibility of coordinating the participant parties. Maintaining the flow of communication between several groups in a project is a critical factor for progressing properly in architectural projects and successfully realizing the projects.

2.6. Summary of the Chapter

In this chapter, the phenomenon of knowledge management has been presented including the aspects of data – information – knowledge, distinction between tacit and explicit knowledge, components of knowledge management and necessary tools and techniques that are used in implementation of knowledge management. Subsequently, managing knowledge from architectural practice point of view has been investigated.

It has been found that, while the general research focuses on the construction industry, there is a lack of studies done regarding knowledge management and its effects on the architectural practice.

The following section introduces the material and methods that are used while exploring knowledge management in the practice of architecture which was found necessary to conduct due to reasons given above.

CHAPTER 3

MATERIAL AND METHOD

3.1. Introduction

This chapter presents the research material and the methodology used in collecting and analyzing the data. In order to have a clear explanation of the concepts, material and method themes are given separately. First, the population and sampling method are explained briefly, and then, the framework which is developed for this study is given in details. Following the framework, the data compilation, which was conducted in the form of a survey, is introduced and finally, methods for analyzing the data, including statistical analysis, are given at the end of the chapter.

In the guidance of the proposed methodology, this study sets to investigate the architectural offices in Çankaya District of Ankara and identify the positive and negative aspects of the applications of knowledge management and put forward a general overview on this aspect. A secondary goal of this study is to humbly inform the architectural offices in Çankaya about the possibilities that are enabled by the knowledge management in order to create awareness on the subject, if possible.

3.2. Material

The population for this research was defined as architectural offices that are actively conducting architectural practice which are registered to the Chamber of Architects. As a first attempt of population selection, all architectural offices that are registered to Chamber of Architects in Ankara, İstanbul and İzmir were considered. The survey was sent to the offices via internet with the support of Chamber of Architects, Ankara Branch and the other two branches. But, this method of collecting

information had failed due to the lack of participation of organizations. Also, the replies to this survey were found to be having missing parts which might easily affect the analysis of the data negatively.

Even though, conducting the survey in three main cities of Turkey would have brought more general findings, the conditions above had led the study to a local population. Due to high rate of its architectural offices, Çankaya District was chosen as the community in which the selection of offices was to be made. Among the sample space of 211 architectural offices that were located in Çankaya District, 15 architectural offices were randomly selected which constitutes approximately 8% of the sample space.

The architectural offices were selected from a list which was provided by the Chamber of Architects, Ankara Branch. The offices were arranged according to the registration number on the list and they were assigned numbers from 1 to 211 by the author of this study. Then, every tenth office on the list was chosen until the required number of 15 offices was achieved.

Majority of these organizations had less than 10 staff. To illustrate, 5 of the offices include between 1-5 full-time working staff and 7 of the offices included between 5-10 full-time working staff (see Figure 3.1). Depending on the literature survey, these offices were categorized according to their number of staff they have, as small (1 to 5), medium (6 to 10) and large (more than 10). Each office in each categorization is also given a number which is given along with the categorization initial. (e.g. S1, M2, L3)

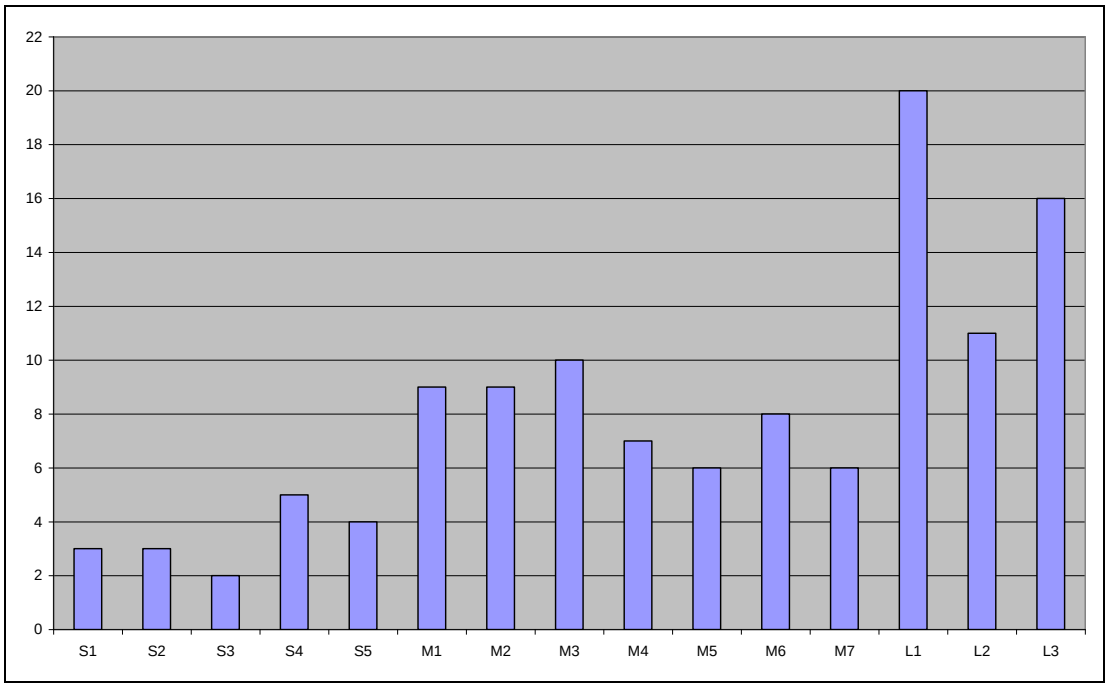

Figure 3.1. Number of personnel working in the selected organizations

The selected offices had been conducting business in different areas of architectural practice (see Figure 3.2). All participant organizations had finished residential projects. 12 of them had also worked in commercial and public projects. Only 4 of organizations had practiced in sport facility projects and restoration.

All the participant offices had been contributing to the architectural projects in pre-design, schematic design, design development and construction documentation phases. 13 of the offices were either preparing bidding documentations or entering project biddings. 8 of the offices had been responsible for construction administration in their histories. Though, only 4 of the offices were conducting systematic evaluation of projects at post-design phase.

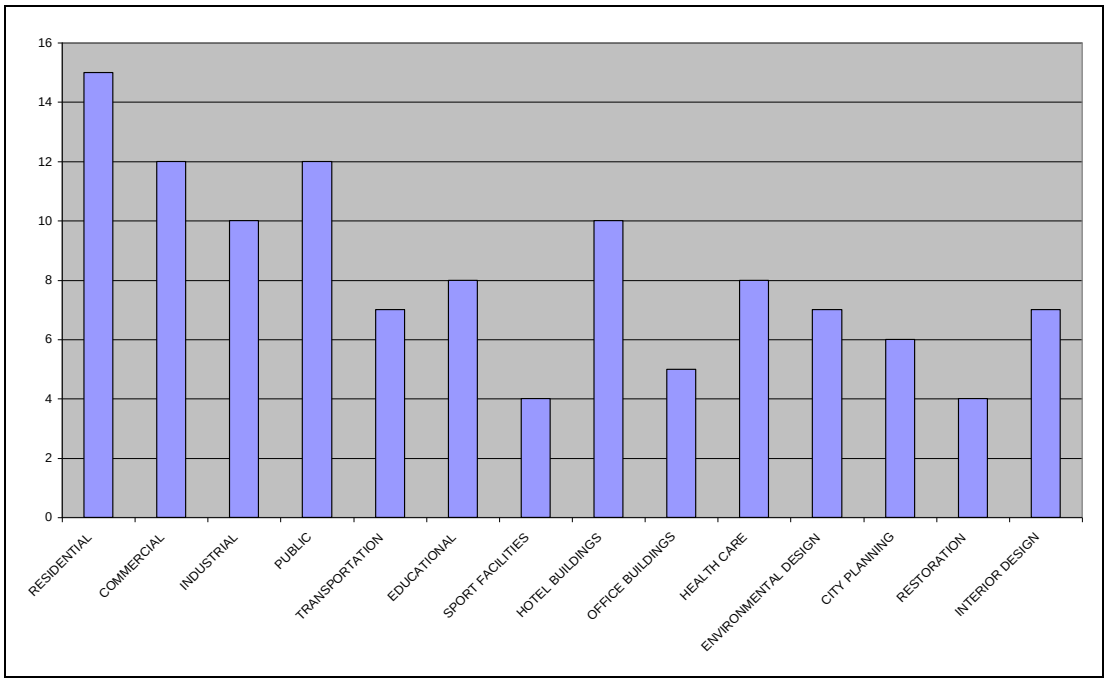

Figure 3.2. Scope of design project types by survey participants

Among the participant organizations, 11 interviewees confirmed that they were aware of knowledge management and applying partially formal or informal related activities. Though, only 5 of the organizations had a legal approval of such application exists in their offices (e.g. ISO9001 certificate). 12 out of 15 organizations approved that they provided a democratic working environment which supports the effective sharing of knowledge. 9 out of 15 organizations were observed to provide their employees with sufficient resources for their improvements. Though, only 5 of the participants were comfortable with sharing their knowledge with other organizations in the industry. Finally, less than half of the organizations believed that their learning capability provides them with competitive advantages over their rivals.

When the interviewees were to evaluate their organization in the terms of work environment and the characteristics of their end products, 9 out of 15 organizations claimed that they had a stable working environment and 12 of the respondents responded that their design solutions were considered as standardized, trustable solutions. 7 out of 15 organizations suggested that their design solutions were client-

oriented and same amount of organizations provided that innovation in design was a priority in their projects. Only two organizations responded that they are working in an informal environment in their offices.

3.3. Method

In the previous chapters, it is mentioned that knowledge management has not become the case recently, but the activities within this phenomenon have recently been defined and general frameworks including these activities have been suggested. The management of knowledge has always been present where the flow of knowledge takes place. Hence, it is vital for this research to investigate the current activities of knowledge management in the Turkish architecture sector at the first place.

In order to define the necessary information to be captured from the selected offices, a general framework for architectural design process, which was based on the literature survey and previous studies, was proposed. The components of the framework were categorized according to the nature of knowledge they possess which was ranging between absolute tacit or absolute explicit (excluding the absolute points as knowledge, at any level, was assumed to have both of the features). The main components were the project environment and the office environment where the latter was the subject of this study.

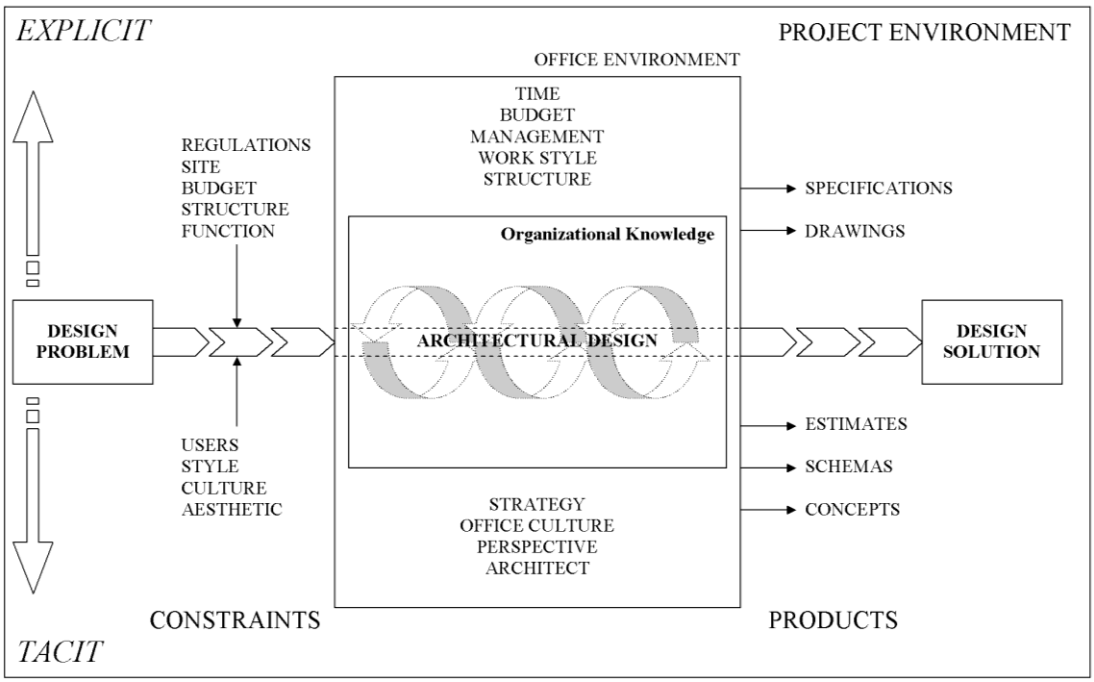

Figure 3.3. General framework for the architectural design process

The project environment was illustrated as the space where any design problem and related project constraints (regulations, site, users, style etc.) took place. The office environment was a sub-space where the analyzed information went through synthesis for a design solution. This synthesis was possible only when the existence of an organizational knowledge was present. The inner constraints (time, budget, office culture, architect etc.) of office environment and the organizational knowledge co-operated and conflicted for the optimum solution and necessary end-products (concepts, drawings, etc.) for the design problem. The office environment was the space of research for this study. Within this space, it was aimed to explore how knowledge was managed and utilized into organizational knowledge within the architectural offices. With this purpose, a questionnaire was prepared and based on this questionnaire; semi-structured interviews were conducted with the executives of selected organizations. Face-to-face interview approach was utilized in order to retrieve sufficient data on both systematic and personal methods applied in the organizations. The main objectives of this survey were defined as:

- To examine the knowledge resources of architectural organizations,
- To observe the methods of managing architectural knowledge,
- To evaluate the barriers and benefits of the knowledge management strategies

The questionnaire consisted of two major parts. The first part included questions about participant information, company background and organizational setting. The second part was focusing on the management of knowledge and subdivided into categories as follows:

- Knowledge sources
- Knowledge sharing, accumulation and dissemination mechanisms
- Barriers and benefits of knowledge-based strategies

The questionnaire was designed according to a framework which was adopted and altered from the study of Dikmen et al. (2005). The original framework investigates the impact of organizational learning competency on the performance of construction companies. Main components of the proposed framework for this research consisted of i) *knowledge sources*, ii) *knowledge mechanisms* and iii) *organizational settings* as shown in Figure 3.4. *Knowledge sources* are divided as internal and external learning sources. *Knowledge mechanisms* are tools that are used for the acquisition, sharing, accumulation, and dissemination of knowledge. *Organizational setting* consists of factors such as structure, culture and strategies that are developed within. Organizational knowledge is crucial for productivity and innovation in the architectural design process. It is assumed that, employees in an organization build up individual knowledge repositories prior to an organizational knowledge can be achieved. Knowledge mechanisms allow these single repositories to contribute into a more effective organizational knowledge. In the framework, it was assumed that mechanisms perform well when:

- the sources are utilized frequently and effectively,
- mechanisms are used effectively to build the organizational knowledge
- an appropriate organizational setting exists to support learning

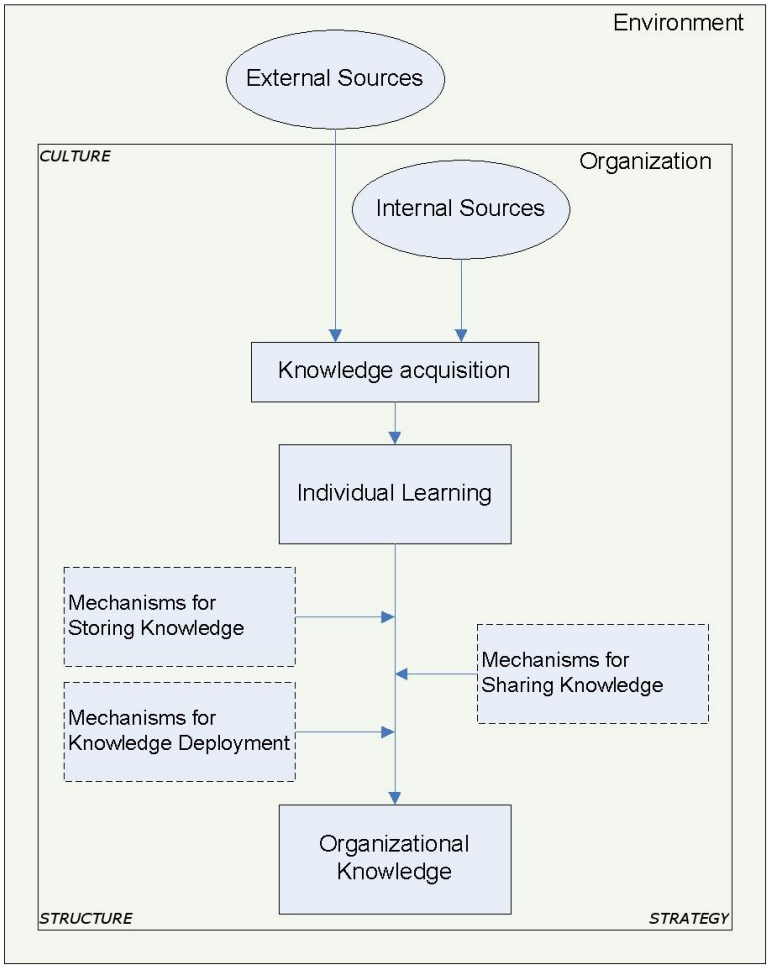

Figure 3.4. Organizational knowledge management framework, adopted from Dikmen et al. (2005, p.170)

The questions in the second part aimed to record both qualitative and quantitative data on the related subjects. For a better organization of the responds, the interviewees were asked to reply in 1-5 Likert-scale implying ‘never’ to ‘very often’ for use frequency of knowledge sources, ‘very low’ to ‘very high’ for availability of stored knowledge and importance of knowledge mechanisms and effectiveness of barriers and benefits.

In the framework, the vast phenomenon of architectural knowledge was attempted to be categorized in a systematic way which could allow the types of knowledge to be identified as tacit or explicit. The architectural knowledge was broken into three

headings such as: (i) design knowledge, (ii) application knowledge and (iii) strategic knowledge.

The design knowledge was defined as the knowledge and ability, which are gained through education and practical experience that is necessary for conducting architectural design and generating project ideas and related products that are created during this process. In this type of knowledge, design constraints, design ideas, schemas, project estimates, drawings etc. were included.

The application knowledge was consisting of general building knowledge that is necessary for realizing the design ideas into real life products. In this type of knowledge, unit costs, productivity, equipment and applied methods were included.

The strategic knowledge was the sum of all knowledge that enables organizations to conduct their business which is necessary not only for architectural offices but all types of business. In this type of knowledge, information about employees, clients, contractors, competitors and country-market were included.

The types of knowledge determined in the framework were questioned while investigating about knowledge sources and mechanisms. In the arrangement of knowledge acquisition, knowledge sharing, accumulation of knowledge and dissemination of knowledge, it was aimed to analyze the flow of each knowledge type given as design knowledge, application knowledge, and strategic knowledge in the architectural offices. Assuming the nature of knowledge in the given types range from tacit to explicit in the given order, it was also aimed to observe the effect of nature of knowledge in the management of knowledge.

3.3.1. Survey on Knowledge Management in Architectural Offices

Face-to-face interviews were arranged with senior management of selected organizations. The interviews are done with a single person, which is in most cases the head architect, or a member of senior management. Considering the fact that, top

management members were possessing due information regarding the knowledge management activities, it was assumed that the participants were qualified in order to give objective and valid answers.

The first part included 8 questions about the organizational characteristics in order to record the profile of the interviewees. Starting with some basic information about the organization and respondent, several important aspects were covered. Questions about the amount and type of projects done, design phases participated in, strengths of the organization and basics of organizational culture were included in the first part of the questionnaire. The last question of this part was critical within the whole survey as the answers put forward the organization's awareness on knowledge management and implied whether the organizational culture was appropriate for knowledge management activities to perform efficiently.

The second part of the questionnaire was aimed to investigate the knowledge mechanisms and learning sources which enabled organizational knowledge to exist. This part included 11 questions which were arranged in the outline below:

1. **Knowledge sources**
    a. **External sources**
        i. Learning sources for individual learning
        ii. Learning from other parties
    b. **Internal sources**
        i. Organizational learning
2. **Knowledge mechanisms**
    a. Knowledge sharing
    b. Knowledge accumulation
    c. Knowledge dissemination
3. **Importance of knowledge mechanisms and sources**
4. **Barriers against knowledge management**
5. **Benefits of knowledge management**

The questions in the second part aimed to record both qualitative and quantitative data on the related subjects. For a better organization of the responds, the interviewees were asked to reply in 1-5 Likert-scale implying ‘never’ to ‘very often’ for frequency of learning sources, ‘very low’ to ‘very high’ for availability of stored knowledge and importance of knowledge mechanisms and effectiveness of barriers and benefits. The interviewees were asked to indirectly answer the questions with Likert-scale and then their comments on the related subject were recorded.

Table 3.1. Knowledge management components and questionnaire items

Components		**Listed items**
EXTERNAL LEARNING SOURCES	Knowledge acquisition: Learning sources for individual learning	External seminars, congresses, exhibitions, tradeshows, printed material, academic studies, internet
	Knowledge acquisition: Learning from other parties	Clients, partners, competitors, universities, consultants, governmental bodies, foreign organizations, non-governmental organizations
INTERNAL LEARNING SOURCES	Knowledge acquisition: Organizational learning mechanisms	Benchmarking, environmental scanning, process-based project learning (post-project appraisal, after action review) , documentation-based project learning (learning histories, cased based reports)
KNOWLEDGE SHARING	Knowledge sharing mechanisms	Teamwork, formal / informal meetings, internal seminars, job rotation, face-to-face communication
	Sharing knowledge in designing	Face-to-face communication, reports, hand drawings, CAD drawings, modeling
	Sharing knowledge in application	Face-to-face communication, reports, hand drawings, CAD drawings, modeling
Accumulation of knowledge: Knowledge repository		Project information, strategic information and design information
Knowledge dissemination: Dissemination of knowledge by learning mechanisms		Documentation, server, intranet, artificial intelligence-based decision support systems, web-based project management systems

In this respect, the questions were asked in the given arrangement. The external and internal learning sources were investigated and frequency of use of each knowledge source and the type of gained knowledge were recorded. Then, the applications of knowledge sharing with employees and partners were investigated. By separately investigating the sharing of knowledge in design and application, the possible differences in managing tacit and explicit knowledge were observed. At this point, the knowledge within the organization was assumed to be utilized at a high level, but it was also very important to be able to accumulate this knowledge for the future applications. The ways of accumulating the different types of knowledge and tools for the dissemination of stored knowledge were questioned subsequently.

Following the knowledge mechanism questions, the level of importance of each mechanism, learning source (external and internal) and of organizational culture within the proposed framework were asked to interviewees. It was important to record the general opinion of the participants' on each component separately and without bias from the previous questions as possible. The given importance levels were compared to prior data about the frequency of use of sources and mechanisms.

In the final questions, the barriers against knowledge management implementations and benefits of knowledge management systems were asked to the interviewees. The list of barriers and benefits were compiled through literature research. The interviewees were asked to evaluate the importance of given items in Likert-scale but also some answers which did not appear on the lists were recorded and utilized with due attention. At the end of each interview, the participants were given a brief of their answers and their opinions were taken and missing parts were completed, if there was any.

3.3.2. Statistical Data Analysis

The survey findings that were given in Likert-scale were presented with 100% segmented bar charts. The significant results were further supported with the related qualitative data. In the case of certain comparisons, statistical analysis methods were utilized.

Two sample dependent (paired sample) Student's *t*-test was used on a sample basis in order to determine whether there were any differences in the effect of barriers and benefits of knowledge management on architectural organizations observed in the following survey at a prescribed 5% level of significance (α=0.05). Also, benefits and barriers were categorized as external and internal, and the same procedure was conducted for these factors.

The data that this study dealt with was categorical data, though it possessed continuity within the given scale that was utilized to codify the answers of participant architects. The *t*-test measures how different the two samples are, which is denoted by t-stat value, and measures the possibility of the difference appearing in two samples from the same population, which is denoted by p-value (significance value). While interpreting the results, if the p value is less than 0.05, there is a significant difference. If the p value is greater than 0.05, there is no significant difference.

3.4. Summary of the Chapter

In this chapter, the material that this study is based on and the methodology of the research have been presented. These include the sample population and its characteristics, the research framework and the methods of compiling and analyzing the data. In the following chapter, the research findings and thorough analysis of derived data are given in detail.

CHAPTER 4

RESEARCH FINDINGS

4.1. Introduction

In this chapter, the survey results and analysis on the compiled data are presented. The survey results are introduced in the arrangement that is provided by the research framework and related observations on these results are given. Data on the knowledge management applications are analyzed in accordance with the purpose of this study. The results of statistical analysis on the derived data are presented after the survey results under a separate subtitle.

The survey results were examined in three main parts. *Part I* examined the learning process in the practice of architecture. *Part II* investigated the knowledge sharing, accumulation and dissemination mechanisms. Lastly, *Part III* identified barriers and benefits of managing architectural knowledge.

4.2. Part I: Knowledge Sources

In the first part, the individual learning sources, learning from other parties and organizational learning mechanisms had been examined. Individual learning and learning from other parties were dependent on external sources or groups. Sources identified for individual learning were seminars, congresses, expositions, tradeshows, publications, academics studies and internet. Groups identified for learning from other parties were clients, partners, competitors, universities, consultants, governmental and non-governmental bodies and foreign organizations. Organizational learning included activities such as benchmarking and project evaluations where information was derived from internal sources.

4.2.1. Individual Learning Sources

The survey results (see Figure 4.1) indicated that internet was considered as the most frequently used individual learning source. 12 out of 15 organizations agreed or strongly agreed that the use of internet was important in collecting information on projects, communicating with producers and firms, accessing material knowledge and receiving information on project applications. Internet was considered as the most practical resource for organizations to access information. For example, Organizations S1 and S5 defined internet as a source of *"more information in less time and space"*. In spite of its advantages, organizations needed to identify how they could benefit the most from the sources on internet. It was clear that the amount of time to locate information and the space needed for storage of this information were important issues. On the other hand, Organization M4 claimed that the comfort of internet had been driving individuals through making narrow research on issues and be satisfied with those available on internet. Similar to this opinion, Organization L2 suggested that with the amount of information and orientation, it was not hard to get distracted and end up with less useful information for your cause.

Organizations agreed on the fact that the emergence of the internet had hindered the usage of the printed material. When the interviewees were asked to compare the printed material with online sources, Organizations S2, M4 and M5 suggested that there was a tendency of not trusting the validity of information on the internet, so that printed material proved to be a more dependable source in that sense. 11 out of 15 organizations agreed or strongly agreed that printed materials were the main sources of knowledge. Organization M2 mentioned that while general information was abundant throughout the internet and websites, it was hard to spot information on specialized issues such as materials and applications. Besides, architects habitually utilize some of the standard books and catalogues at any phase of design process, so it was evident that printed materials were valued. It was also observed that, organizations which preferred printed material as main sources of knowledge, tended to use internet as a means of rapid communication. Organization L3 gave a brief of this situation by stating that *"in general, we utilize Internet for receiving*

bidding information and procedures, finding general detailing and applications in websites of other firms, and researching printed material for specialized issues in architectural projects".

Other than printed or online sources, tradeshows were observed to be preferred by 9 of the organizations as useful information sources in order to "*have the feeling*" of advances in AEC industry and *"see with their own eyes"* how the applications were made. Organizations emphasized the importance of experiencing the matter in real life and agreed that this experience was more valuable in some ways than those of other sources.

By four organizations, project competition expositions were considered as perfect occasions to interact and share knowledge with colleagues and specialists. As defined by Organization M4, *"architects are a group of professionals who can gather and discuss in a critical manner in ease".* The organizations agreed that they got the chance to compare themselves with other architects, receive comments and critiques on many dimensions of projects and improve themselves at all directions. One of the interviewees with a part-time academic position emphasized on the benefits of student jury seminars by claiming that *"one way of keeping yourselves updated is evaluating 80 projects a semester".* The interaction with young architect candidates was considered as an important means of receiving fresh information.

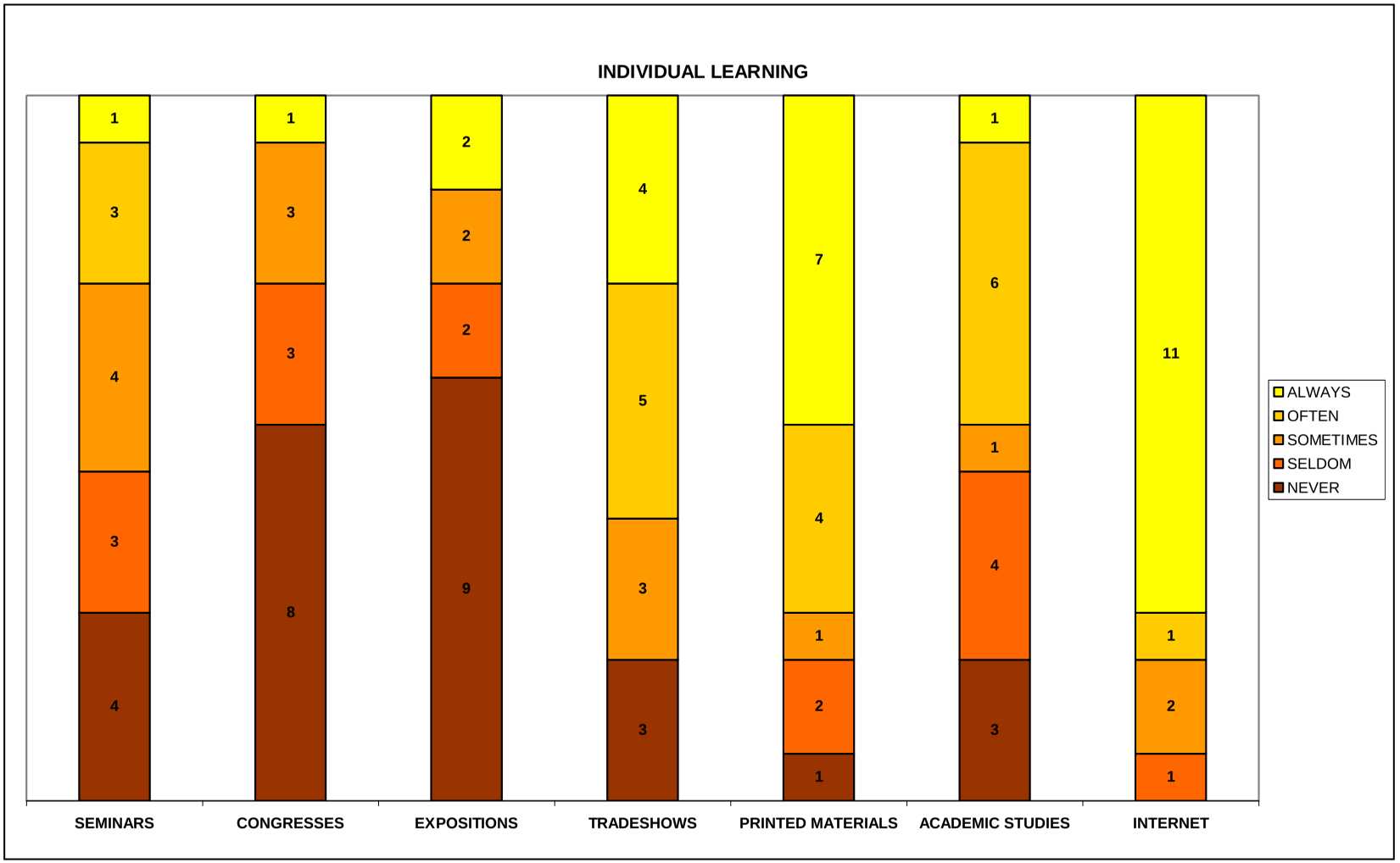

Figure 4.1. Individual learning sources

4.2.2. Learning from Other Parties

Architectural organizations are regulated by professional and governmental bodies, dependent on construction industry and provide service for clients in public or private sector (Emmitt 2007, p.173). The survey results (see Figure 4.2) were implying these facts as the top three parties that organizations were in frequent communication are *clients, partners* and *governmental bodies.*

Clients and partners were considered as essential information sources throughout the whole project processes. 14 out of 15 organizations confirmed that they communicated with clients frequently and 11 organizations suggested partners as a regularly utilized source. Organization S1 and S4 clearly informed that they *"record every bit of information received from clients as it is not predictable when you may need them*". Organization S3 and M5 added that it was also important to lead the clients rather than merely sharing ideas. Organization M5 proposed architects to be able to evaluate clients and be capable of giving future development plans, just like an image maker. Organization S4 pointed out that this communication was limited by the knowledge collection of the clients, which was also referred as the effect of shared knowledge in communication in previous chapters. Consequently, the client affected the amount and quality of the information.

Organization M1 defined governmental bodies as *"the greatest client due to the amount of project works, material information, application experience and rights*". Depending on the client profile, the frequency of communication varied among organizations but all organizations made use of government repositories for receiving regulation information. 13 out of 15 organizations agreed or strongly agreed that they frequently communicated with governmental bodies for several reasons such as receiving bidding information, updating regulations, etc.

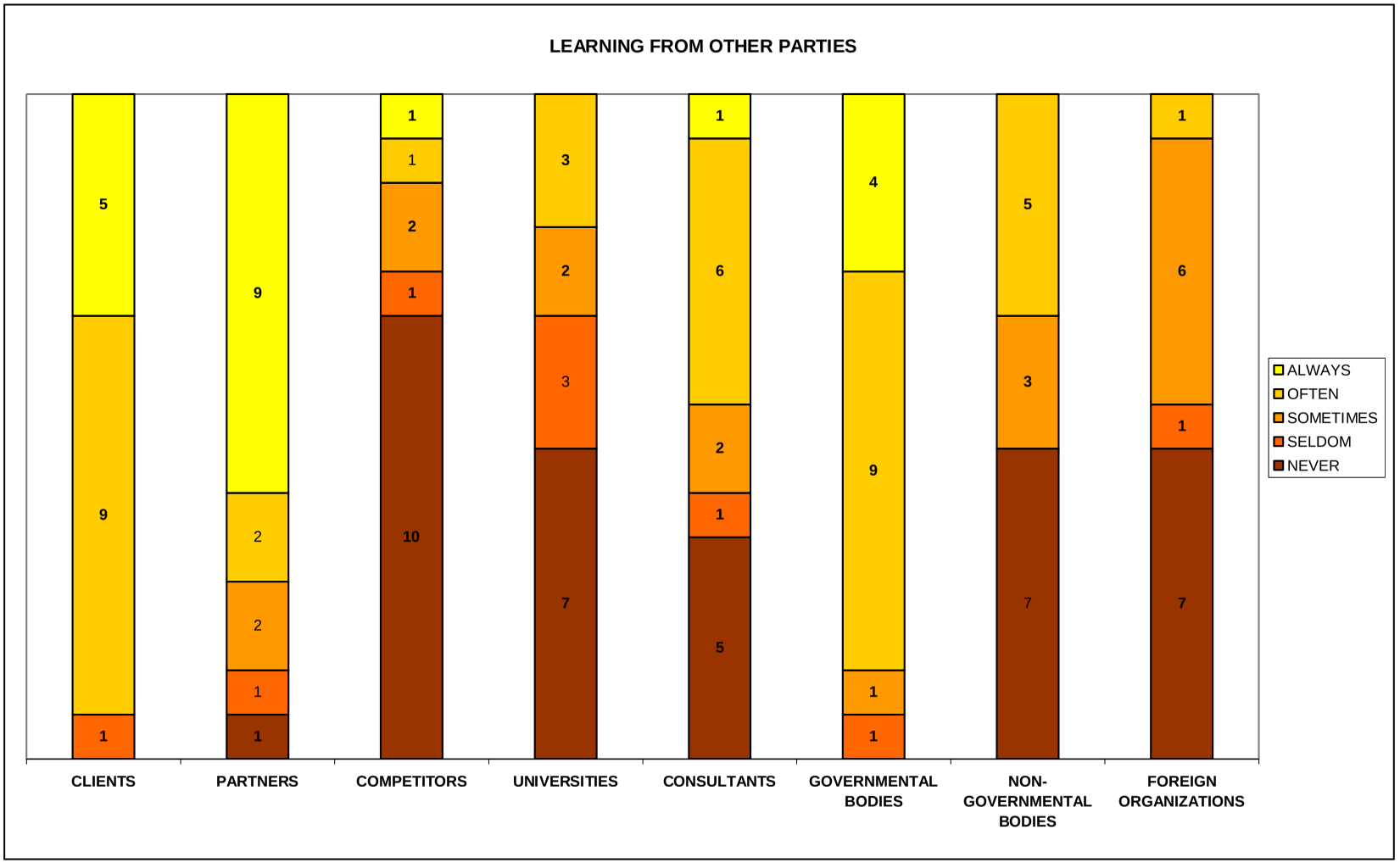

Figure 4.2. Learning from other parties

The collaborative working environment in architectural projects was mentioned by most of the organizations. The necessity of cooperating with other groups in architectural projects such as partners and consultants was emphasized. 11 out of 15 organizations considered project partners as one of the most communicated group within the project environment. 7 organizations referred to consultants frequently for dealing with specialized issues. Organization L2 expressed the vitality of working with specialists by repeating a local phrase which suggests working with experts regardless of cost. Organizations M2, M6, L2 and L3 architects agreed that they were not meant to provide every bit of information and application for building projects and leveraged the importance of consultants.

While communication with other parties was proved to be important for organizations, interaction between architectural offices seemed to be problematic and relied on personal relationships due to several factors. Only two organizations claimed that they were sharing knowledge with competitors frequently. Organization M5 and S5 emphasized the importance of sharing best practices with their competitors for the sake of architectural industry, especially in restoration, by saying that *"there is no better way of learning than experiencing problems on site and no single architect can experience them all".* The intentions were noble and reasonable but Organization M4 and M6 referred to the lack of legal regulations on the transmission of intellectual property rights, trademarks, and copyright issues. Even though, the lack of collective studies and sources was considered to be a major problem by most organizations, Organization M4 admitted that they rejected to contribute to a database project on application details lead by Chamber of Architects due to similar reasons.

4.2.3. Organizational Learning

Most of the organizations claimed that they improved their knowledge repositories mainly through the evaluation of projects during or after the design process. According to the results (see Figure 4.3), 11 out of 15 organizations preferred after-action reviews for evaluation during projects and 10 organizations utilized post-

project appraisals as a method of collecting information after their projects. The common reason given by interviewees neglecting during and/or post project appraisals was the lack of time. Either, the offices claimed that they barely had time to finish and submit their projects during the design phase or they immediately focused on the next project and delayed general post project evaluations.

11 out of 15 organizations stated that they had been collecting and creating knowledge mostly during the project design with after-action reviews by continuously evaluating right after problems and revising for better solutions. Organization M4 and L2 suggested that the evaluation during project design focused on the partial solutions and implementation in the projects and claimed that this was an almost reflexive method used in project designing. Due to the nature of this ad-hoc method, Organization L2 implied that the information collected was at best contributing to the experience of architects but could not be recorded. Organization S3, M5, S5, L2 and L3 championed the benefits of project consultancy during construction phase. Sharing more time on the project by also shouldering the consultancy service, they admitted that they received valuable experience and application information which could be recorded in a more formal manner but also they became capable of providing better solutions for the real-life product.

Post-project appraisals were frequently utilized by 10 organizations in order to collect information in an organized manner and share time for archiving their projects for re-use in the future. Organization M4 and L2 claimed that general findings that were easier to document could be acquired by this method. It was observed that organizations had developed different methods for this activity. While some methods could be considered as organized, other methods were very personal and unique in their own. Organization L1 stated that they built two-men teams from architectural, static and mechanical personnel in order to update their archives after projects. Organization L2 had a more personal approach for post-project appraisal and preferred spending time in the finished projects and interacts with users to share their feelings in person.

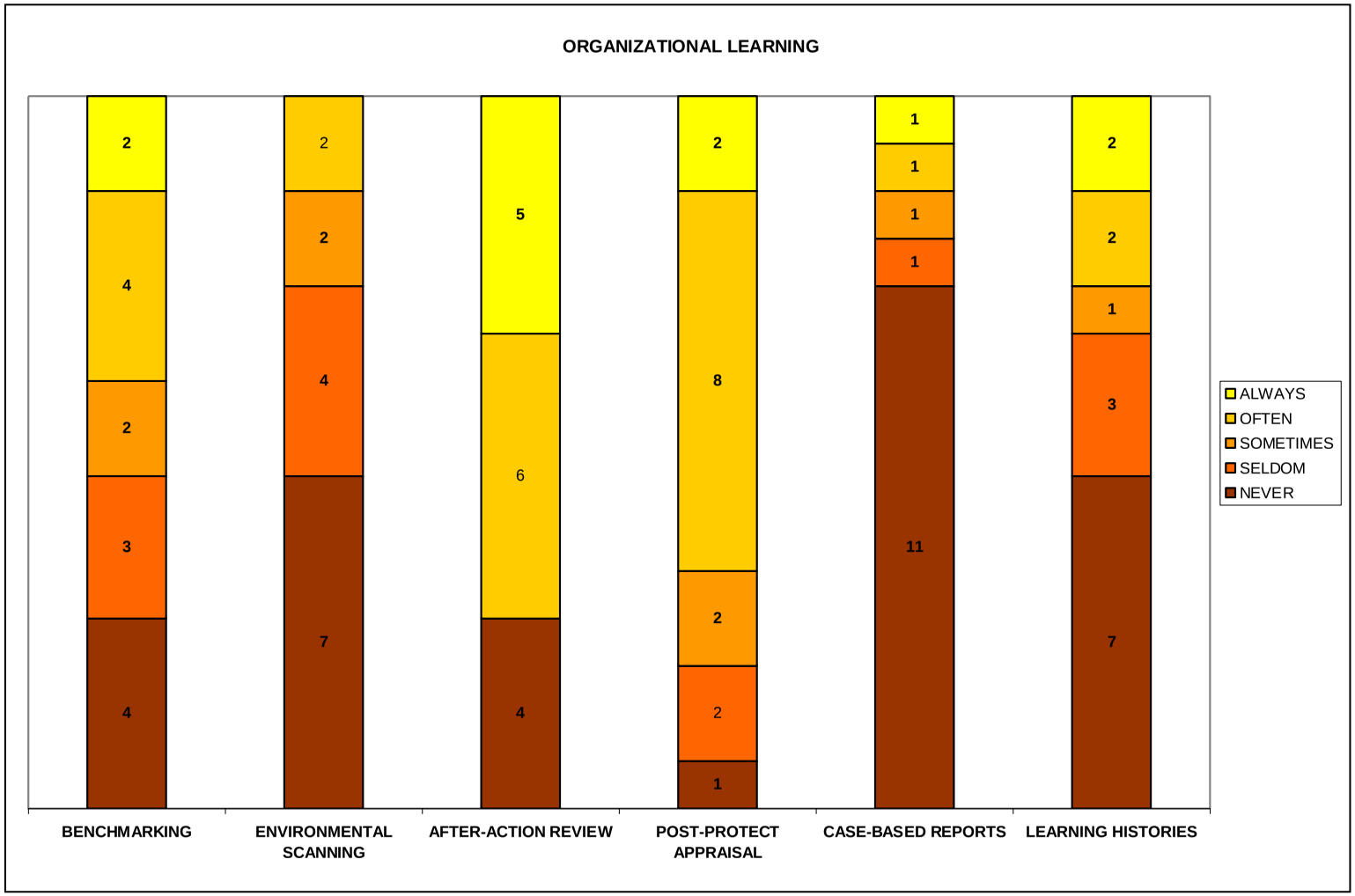

Figure 4.3. Organizational learning mechanisms

In the survey, it was observed that organizations tended to rely on their archive of projects and drawings but did not spend adequate time to prepare evaluation documentation on their projects. Only 2 out of 15 organizations agreed or strongly agreed that case-based project reports (collection of similar cases) were frequently used and only 4 organizations generated learning histories for their projects on a regular basis. Due to the nature of restoration works, Organization M5 and S5 stated that they had been recording and documenting application information and information about material in several forms, written and in photo albums. Though, Organization S5 admitted that *"procedures in the projects done have remained in our minds. We couldn't transfer this experience to some sort of media, no further than daily conversations and chats. I feel a need of writing down this experience of mine; it is not easy to earn practical knowledge"*.

7 out of 15 organizations admitted that internal benchmarking was futile due to several reasons such as economical problems, lack of time, and churn rate of staff, unpredictable market conditions and project volume. But it was observed that, architectural offices were in close interaction with each other and naturally performing competitive benchmarking in order to improve themselves. Organization M4 claimed that they were comparing themselves with other offices in *"not an ambitious, but in a criticizing yet appreciating manner"*.

4.3. Part II: Knowledge Sharing, Accumulation and Dissemination Mechanisms

In the second part, knowledge sharing, accumulation and dissemination mechanisms had been examined. While observing in the methods of knowledge sharing, preferences on the media applied for sharing knowledge were also questioned. The use of information technologies were also investigated in the accumulation and dissemination of architectural knowledge. Finally, importance levels of each mechanism and organizational culture were evaluated by the participants.

4.3.1. Knowledge Sharing

According to the survey, organizations shared their knowledge mainly through face-to-face communication within their office and utilized some basic electronic communication tools (e.g. instant messaging, e-mail) frequently within and out of their organization. While, all organizations claimed they preferred both methods for sharing knowledge, 14 out of 15 organizations strongly agreed that face-to-face communication was the most frequently used method. 7 out of 15 organizations strongly agreed electronic communication tools were utilized the most (see Figure 4.4).

As mentioned previously, the amount of tacit knowledge in architectural design process has rendered the face-to-face communication as the main method of transferring information and as an enabler of other sharing methods to perform efficiently. Though, it should also be noted that the scale of the participant organizations were very small, so the need for organizing the transfer of knowledge within the offices was not as crucial as large organizations.

Face-to-face communication was also vital for the training of employees within the organizations. Organization M6 applied training sessions in which office standards and architectural drawing standards were given to employees. Organizations M5 and L2 utilized a mentor-apprentice relationship to train their employees up to a satisfying level. Other than specific applications, all organizations mentioned the importance of training through project design in time and leveraged the value of face-to-face communication within office.

All participant organizations were observed to make use of electronic communication tools very frequently in some ways. Due to the fact that AEC projects were realized by collaboration of multi-disciplinary teams, the most common way of usage among the participant organizations was the rapid information transfer between partners and engineers.

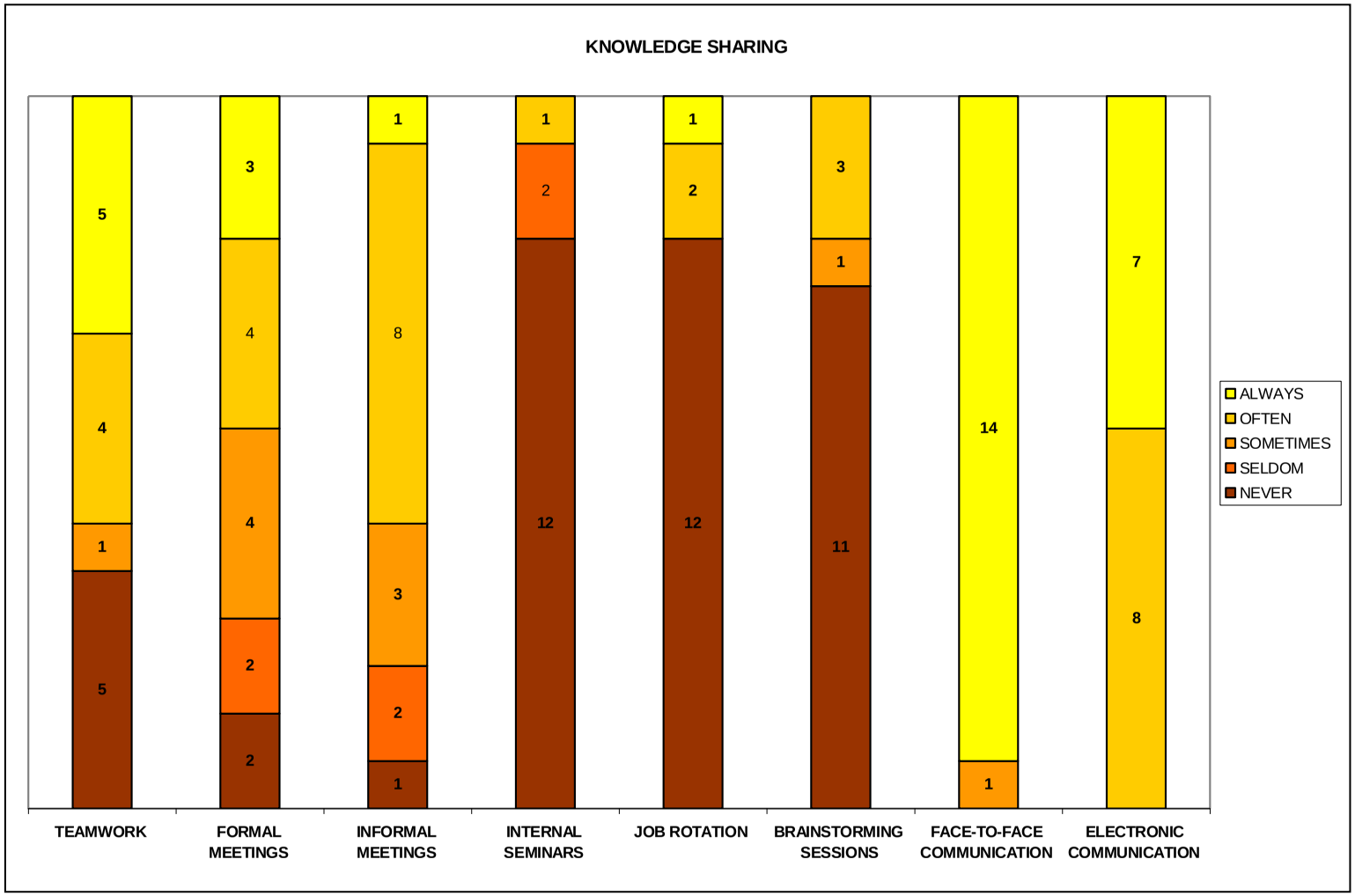

Figure 4.4. Knowledge sharing mechanisms

4.3.2. Knowledge Accumulation and Dissemination

The results of the survey (see Figure 4.5) indicated that organizations were utilizing printed and electronic media as the main media of accumulating their knowledge. Besides the printed material in their library, organizations tended to keep important documents such as notifications, mails, intermediate and final products on paper. Other that these, all organizations except Organization S5 agreed on that their digital archive had become larger than paper archive. It was seen that projects generated in CAD programs were all archived in digital media and printed versions were also stored for administrative purposes.

For accumulating knowledge in digital format, CD-DVDs, external hard disks and mobile disks were utilized. Several organizations claimed they maintained the security of their files by updating their mobile disks daily. None of the organizations had an archive specialist or a similar position, consequently in most organizations; it was the responsibility of group leaders and technical personnel to maintain the security and validity of files. In both paper and electronic documentation, ad-hoc methods that were heavily specific to each organization were preferred for locating the stored knowledge. Basic catalogue and categorization systems were the most common approaches for organizing archives.

All of the organizations agreed or strongly agreed that they preferred electronic documentation as a means of accumulating and disseminating knowledge. However, few organizations had a structured system for organizing their archives. Only 6 organizations claimed that they had a catalogue displaying the locations of files. Most of the organizations depended on their tacit knowledge for retrieving necessary information. In general, technical personnel was comfortable with finding information that they had been responsible from, but it was one or two individuals who knew what was where. Although, categorization of files according to project type, name and date were observed, it was apparent that more thorough and practical systems were required for the organizations to fully utilize their knowledge repositories.

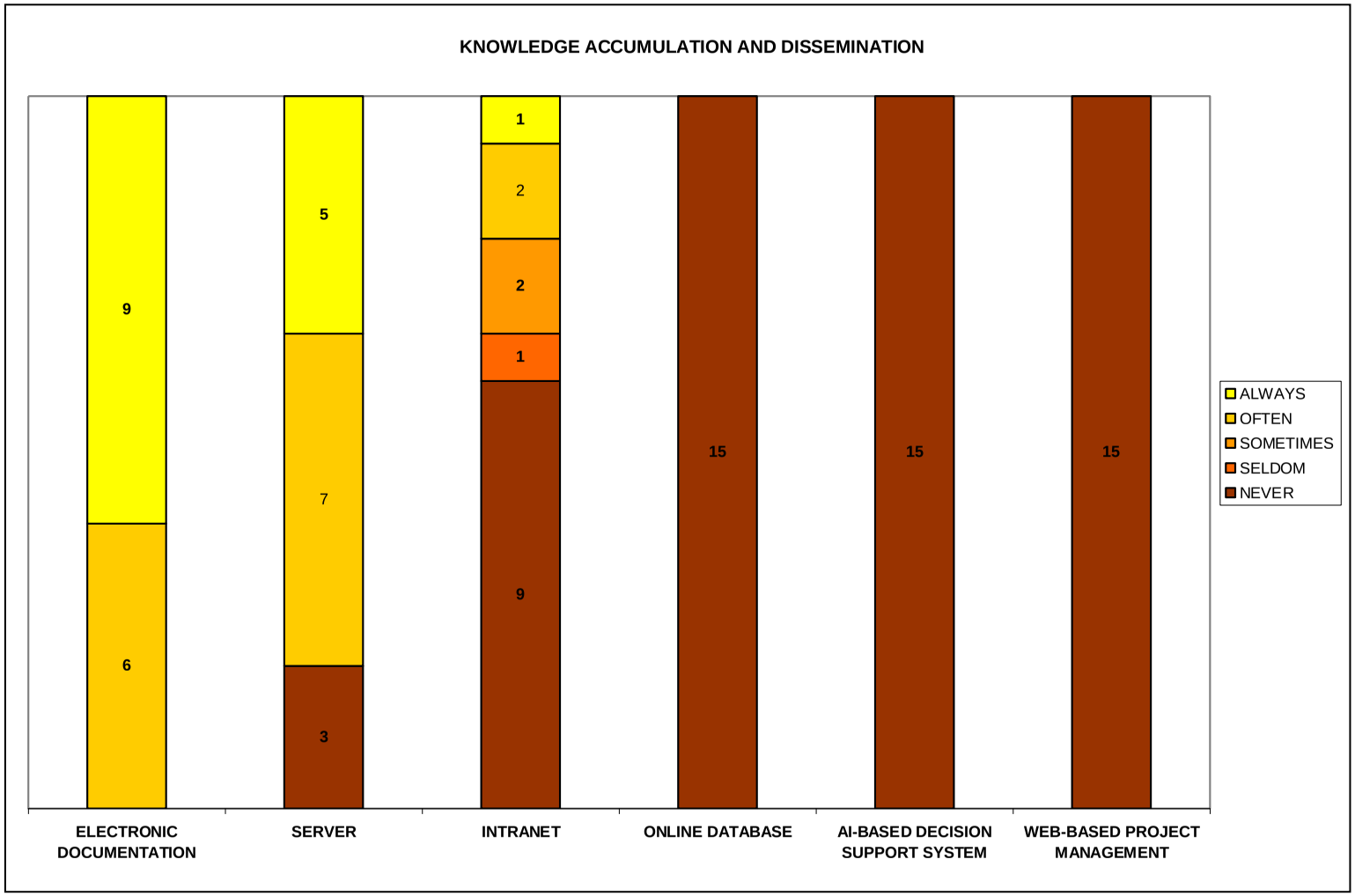

Figure 4.5. Knowledge accumulation and dissemination mechanisms

12 out of 15 organizations utilized servers in their offices to disseminate their information. Due to their very small scale, 3 of the organizations did not consider it necessary. Servers were utilized for rapid sharing of information within office and accessing distributed knowledge with ease. While, most organization preferred evaluating project drawings on paper, Organization L2 utilized their server as a simultaneous control method in design process. The head architect could check the drawing files located on server while technical employee continued on working on the same file. This was claimed to be a practical method which also saved time. It should be noted that most organizations considered computer-based evaluations of projects as a disadvantageous method since excessive amount of details were stored in CAD drawings. It was not easy to grasp all these details from the computer screen. As a result of this, most organizations preferred paper-based project evaluations.

According to the survey, advanced knowledge dissemination methods such as online databases, AI-based decision support systems and web-based project management systems were not utilized by any organization. Intranet, which is considered as a major enabler in knowledge management in the literature, was preferred by only 3 organizations as a frequently used method. Organization M4 utilized a common mailing space for each project to communicate with employees and engineers. Organization L3 had provided an area of digital space in their computers accessible via internet. Organization S4 made arrangements and planning in their web space.

4.3.3. Components of Knowledge Management

When interviewees were asked to evaluate the importance of components of knowledge management, the organizations implied their appreciation of managing knowledge by giving ratings to all components. Among the components, 14 out of 15 organizations agreed or strongly agreed that knowledge accumulation was very important. 12 organizations agreed or strongly agreed that knowledge acquisition, both external and internal, was also vital in knowledge management. Organizational culture was emphasized by 11 organizations as an enabler of all components.

Although organizations had proved their dependence on organizational repositories, it could be seen that they considered capability of collecting knowledge to important as well. Organizations M1, S4, M5 and S5 stated that being able to retrieve knowledge from own projects and embracing this knowledge were essential. Organization S1 and S5 regarded the components as a whole and stated that in case you lacked knowledge in mind and in archive and showed weakness in any of the components, knowledge management was not possible. Organization M2 added that "*every project in archive has some sort of an expiration date, after a while there remains only partial solutions you may make use of…*" Organization L1, M3 and M7 stated that collecting information from other sources was vital for keeping the knowledge repositories updated. Organization S3 and L2 noted that the amount of knowledge outside was always greater than an organization could have in its repository. Organization L2 considered receiving information from outside as the key to create new ideas. The interviewee stated "*the moment you are satisfied with what you have and stop collecting information, you enter a vicious circle and probably, it is time you quit this job.*"

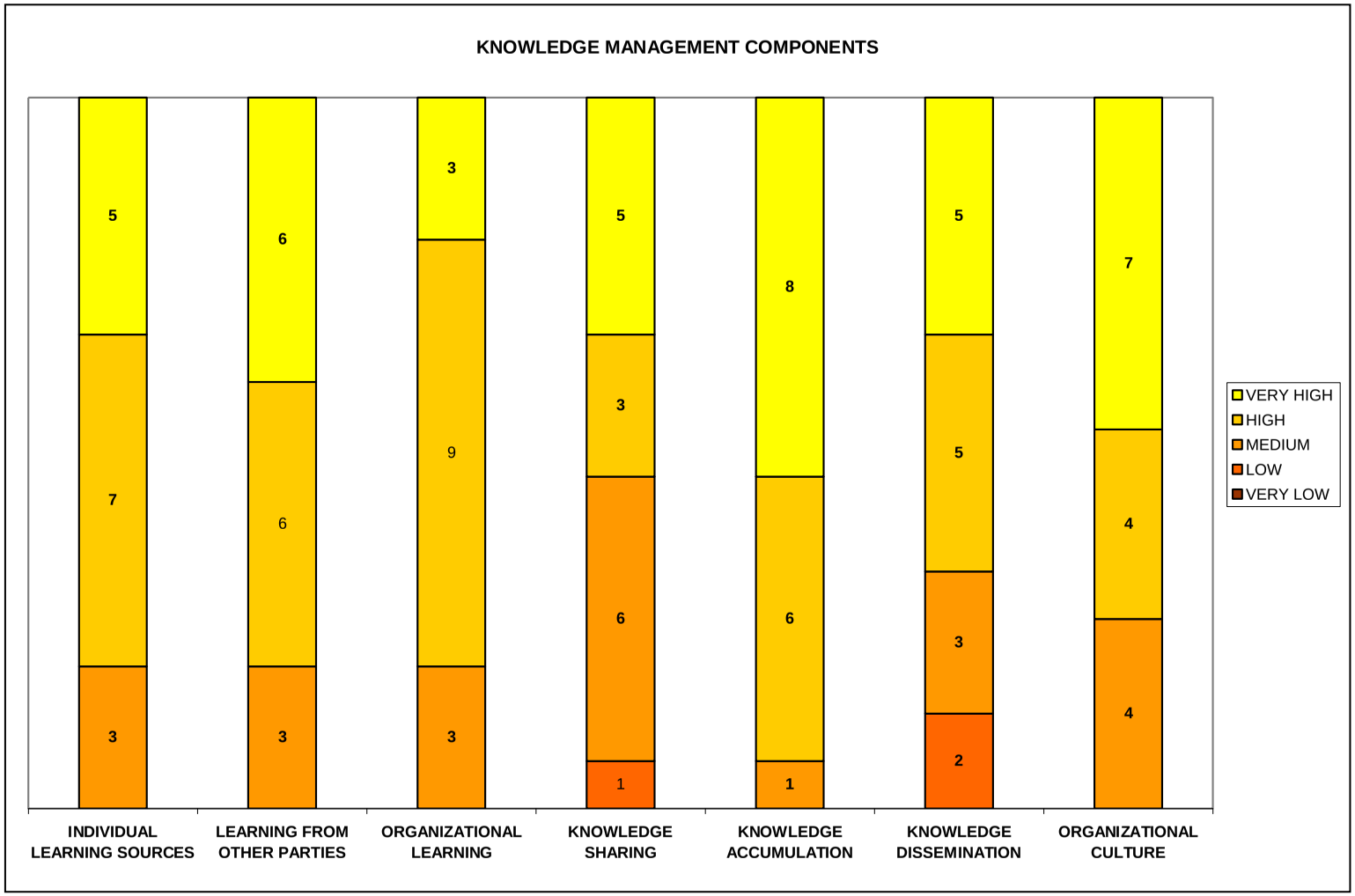

Figure 4.6. Importance of knowledge management components

While knowledge sources and mechanisms were observed to be valued by the organizations, organizational culture was highlighted by most of the participants as the enabler factor for the given mechanisms. Organization M1 and S2 defined organizational culture as the key for the continuity of the architectural offices and activities performed within. The interviewee claimed that without commitment and continuity of the employees, building up and maintaining a knowledge repository was impossible. Organization M3, M4 and M5 pointed out that only in a knowledge appreciating environment; employees can take the due responsibility with executives to establish a knowledge managing organization. Organization M6 stated that responsibility and sharing of knowledge and solutions had significant impact on the design activity. According to Organization M1 and L3, the ultimate purpose in managing knowledge was the continuity of knowledge collections through employees, projects and generations (see Figure 4.6).

4.4. Part III: Barriers and Benefits of Managing Architectural Knowledge

Barriers and benefits of managing architectural knowledge have been examined in the third part of the survey. The organizations were provided with common knowledge management barriers and benefits and their opinions were analyzed.

4.4.1. Barriers of Managing Architectural Knowledge

The results of the survey (see Figure 4.7) indicated that 13 out of 15 organizations regarded lack of standard processes as the main barrier against managing architectural knowledge. Insufficient time and unique nature of architectural projects were noted as strong barriers by 9 organizations. The lack of management support and the employee resistance were mentioned as effective barriers by 7 of the participants. None of the organizations neglected the effect of employee resistance. This implied that organizations were not only willing to alter the way they managed knowledge, but also were aware that this was only possible with the support of their employees. Furthermore, 14 out of 15 organizations considered lack of time as an equally or more effective problem when compared to the funding of knowledge

management implementations. The effect of insufficient time was also apparent in the fact that there was not enough documentation of collected knowledge.

13 out of 15 organizations strongly agreed that the lack of standard processes, information formats and clearly defined norms in architectural applications as the main barriers of managing architectural knowledge. Organization M1 claimed that there was no methodology of managing knowledge in the architectural industry and Organization M1, S2, M2, M5 and L2 added that the scarcity of collective knowledge resources affected the accessibility of desired knowledge negatively. Organization S3 and M2 also mentioned the burden of accessing the vast number of resources in several formats to gain due knowledge. Organization L1, S3 and M6 complained about the rapid changes in the resources and content of information, which rendered collecting and archiving knowledge very hard and exhausting due to the need for continuous checking and updating. Also, working with the multi-disciplinary teams was regarded as an effective barrier by 8 out of 15 organizations. According to these organizations, collaborative working environment with several parties enhanced the problem of lack of standards even more. Organization M4 argued that *"organizing and coordinating parties from different disciplines is already a huge, time wasting responsibility on the architect, and when there are no standards for activities, the problem grows even more"*. Despite the fact that organizations solely attempted to standardize their activities, these attempts remained very specific to each organization. Organization L2 compared the availability of regulation books and standard catalogues in Turkey with those in foreign countries and stated that the gaps in regulations and undefined building applications were the origins of lack of standards. Organization M5 pointed out the absence of building institutions which could provide an across-the-board definition for design activities and information.

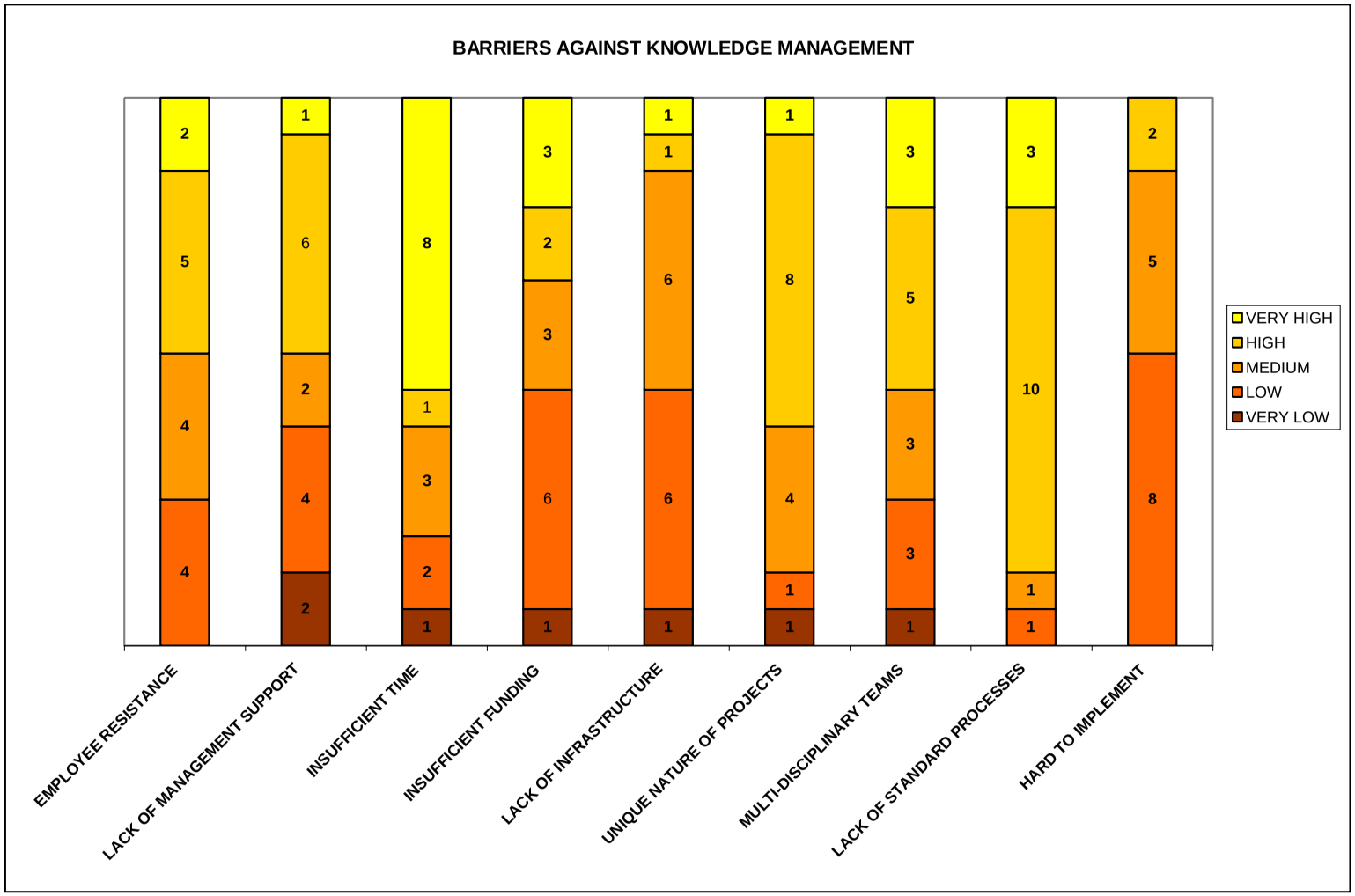

Figure 4.7. Barriers of managing architectural knowledge

The low-profit margin, when compared to the effort spent in the architectural industry, was considered as the major problem in not providing due time and funding for managing activities. Only one organization neglected the lack of time and funding as barriers against knowledge management activities. 4 out of 15 organizations (S4, M4, M6 and L2) strongly emphasized on the low ratio of profit to project amount in Turkey. Organization S4 claimed that architects produce the largest amount of information in construction project life cycle, bearing most of the responsibility and in charge of the coordination. The interviewee stated that the lack of appreciation of drawings and services given by architects in the industry caused the unfair distribution of profits among the AEC groups. Organization M3 and L2 agreed at this point and added that the absence of professional union structures in architectural industry. The interviewees suggested that the low profit and payments also caused short-term job relations, increased the turn-over rate and hindered the investments made on knowledge management. According to the survey results, it was apparent that time and funding were major problems within offices, but when results for both barriers were compared, only 5 organizations considered insufficient funding as a significant factor. This implies organizations were willing to invest in knowledge management for the sake of possible benefits.

Organizations agreed on the fact that application of knowledge management systems was easier than the implementation phase. While, only 2 out of 15 organizations considered the application of knowledge management systems as a major problem, organizations emphasized on the need for professional support on implementation phase. Organizations M2, M6, L2 and L3 suggested that archive specialists and IT managers were required for a better arrangement of organizational knowledge at the beginning.

4.4.2. Benefits of Managing Architectural Knowledge

The results of the survey (see Figure 4.8) indicated that all the organizations identified the benefits of knowledge management systems. 14 out of 15 organizations believed that the main benefit of managing architectural knowledge was the

increased productivity within the office. 12 organizations mentioned the enhanced employee satisfaction as a major benefit. 11 out of 15 organizations considered the decrease of re-work as a significant benefit. It was observed that organizations leveraged the support of knowledge management as an improvement on the office activities and internal issues. On the other hand, the participants showed hesitation on the possible increase on profit and emerge of innovation in design solutions where 6 of the organizations agreed with former and 5 organizations agreed with the latter. Also, due to the fact that client satisfaction was regarded as a major benefit by a lesser portion of organizations, by 10 out of 15 organizations seemed not to be expecting much appreciation from outside but were eager to see developments within their offices.

This situation could be related to several factors. Firstly, there has been a common opinion among the organizations on the underestimation of the design works in the construction industry. The general depreciation of governmental institutions regarding the knowledge assets did not allow organizations to increase their profits even if they had enhanced their productivity. Organization S4, M4, M6, L2 and L3 criticized the perspective of government and clients toward design works and pointed out that there was no regulation on competitive advantages they might gain from increasing their performances, volume of works or establishing a long-term company. Secondly, the interviewees also agreed that in the profit-oriented construction industry, the clients were merely interested in the architectural quality and at any cost, they were going to reject appreciating their works as default.

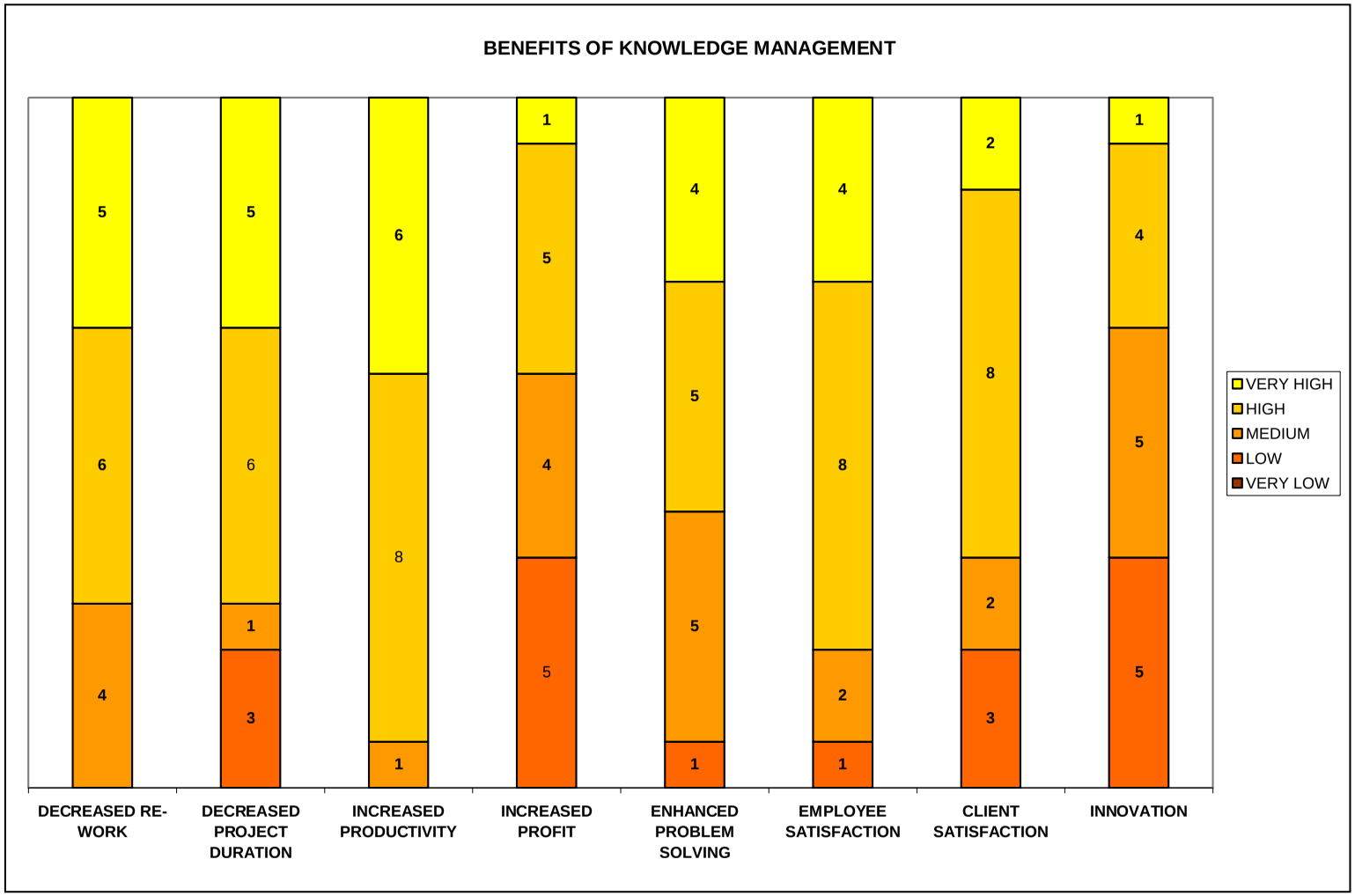

Figure 4.8. Benefits of managing architectural knowledge

In the survey, there was not a consensus on whether knowledge management could bring innovation to design or not. While, 5 organizations agreed or strongly agreed that innovation in design could be expected as a benefit, 5 organizations claimed otherwise. One of the reasons given for this opinion was that the technological advances, such as CAD tools, had only brought speed to production up to now. This had enabled the production of project documents faster than ever and decreased the project durations but it had also shortened the deadlines given by the public or private clients. As a result, the amount of time required for designing had decreased without much gain. Organization M5 and S5 suggested that this condition had brought standardized design solution with less quality.

4.5. Statistical Tests Regarding the Survey

According to the survey results, three hypotheses were presented in this study. In order to evaluate the validity of these hypotheses, two-sample dependent Student's t-tests were applied (Neter et al. 1992, p.404-405). Three main hypotheses proposed for further evaluation were as follows:

Hypothesis I

Null Hypothesis: There is no significant difference between the effects of barriers and benefits of knowledge management on organizations.

Alternative Hypothesis: The benefits of knowledge management are considered to be more effective than barriers.

(H_0: $\mu_1 = \mu_2$, H_A: $\mu_1 > \mu_2$ where μ_1= benefits, μ_2= barriers)

Hypothesis II

Null Hypothesis: There is no significant difference between the effects of external barriers and internal barriers of knowledge management on organizations.

Alternative Hypothesis: The external barriers of knowledge management are considered to be more effective than internal barriers.

(H_0: $\mu_1 = \mu_2$, H_A: $\mu_1 > \mu_2$ where μ_1=external barriers, μ_2=internal barriers)

Hypothesis III

Null Hypothesis: There is no significant difference between the effects of internal benefits and external benefits of knowledge management on organizations.

Alternative Hypothesis: The internal benefits of knowledge management are considered to be more effective than external benefits.

(H_0: $\mu_1 = \mu_2$, H_A: $\mu_1 > \mu_2$ where μ_1=internal benefits, μ_2=external benefits)

Hypothesis I: Comparison of barriers and benefits of knowledge management on organizations

Knowledge management is a recent phenomenon and most of the implementations are at an experimental and immature stage. For an organization to facilitate a systematic approach, the will and support of top management is extremely important for the further development of knowledge management activities. According to the survey, it was seen that the effect of barriers against knowledge management was not regarded as significant as the possible benefits by the executives of the organizations. According to two sample dependent Student's t-test, t-stat for the sample data was calculated to be ±2.552 ($\pm t_{0.05\ (14)} = \pm 1.761$). The null hypothesis which implied that the effect of benefits of knowledge management is equal to that of barriers was rejected at the 5% level of significance. Also, the significance value (p-value) was less than 0.05 (p = 0.023). The $\overline{D}$ value ($\overline{D}$ = -0.474) enabled us to determine that the effect of benefits was greater than that of barriers. The test results implied that the benefits of knowledge management had significant effect on architectural organizations. Taking into the account of the fact that architects were already shouldering the responsibility of organizing different parties in projects and dealing with a large amount of information, it can be claimed that they were experienced in dealing with given barriers.

Hypothesis II: Comparison of external barriers (e.g. insufficient time, lack of standard processes, multi-disciplinary working environment and unique nature of projects) and internal barriers (e.g. employee resistance, insufficient funding, hard implementation of knowledge management and lack of top management support and infrastructure) of knowledge management on organizations.

It was observed that organizations were emphasizing more on barriers related with AEC industry, but they considered barriers originating from their office less effective. In order to analyze this condition, a hypothesis was proposed which claimed external barriers such as insufficient time, lack of standard processes, multi-disciplinary working environment and unique nature of projects were considered as more effective than internal barriers such as employee resistance, insufficient funding, hard implementation of knowledge management and lack of top management support and infrastructure. According to two sample dependent Student's t-test, t-stat for the sample data was calculated to be ±3.248 ($\pm t_{0.05\ (14)}$ =±1,761). The null hypothesis which implied that the effect of external barriers of knowledge management is equal to that of internal barriers was rejected at the 5% level of significance. Also, the significance value (p-value) was less than 0.05 (p = 0.006). The $\overline{D}$ value ($\overline{D}$ = -0.763) enabled us to determine that the effect of external barriers was greater than that of internal barriers. The test results implied that external barriers had significant effect against the knowledge management.

Hypothesis III: Comparison of internal benefits (e.g. productivity, decreased re-work, enhanced problem solving, and employee satisfaction) and external benefits (e.g. client satisfaction, decreased project durations, increased profit, and innovation in design) of knowledge management on organizations.

When benefits of knowledge management was analyzed according to categorization such as being internal and external, internal benefits such as productivity, decreased re-work, enhanced problem solving, and employee satisfaction were considered as more effective than external benefits such as client satisfaction, decreased project durations, increased profit, and innovation in design. According to two sample dependent Student's t-test, t-stat for the sample data was calculated to be ±4.153 ($\pm t_{0.05\ (14)}$ = ±1.761). The null hypothesis which implied the effect of internal benefits of knowledge management is equal to that of external benefits was rejected at the 5% level of significance. Also, the significance value (p-value) was less than 0.05 (p = 0.001). The $\overline{D}$ value ($\overline{D}$ = 0.633) enabled us to determine that the effect of internal

benefits was greater than that of external benefits. The test results implied that internal benefits had significant effect on architectural organizations.

4.6. Summary of the Chapter

In this chapter, the results of the study have been given in detail. The results have been presented in the arrangement of knowledge sources, knowledge mechanisms and barriers and benefits of managing architectural knowledge. In the following chapter, important aspects of these results are underlined and necessary comments are made as a summary of the research. Depending on the significant aspects of the study, a thorough discussion is also presented.

CHAPTER 5

CONCLUSION

5.1. Introduction

In this chapter, the survey results are discussed and presented with relevant recommendations. First, a summary of research is given and important findings are highlighted. Then, these findings are further discussed in the respective subheading. Findings of the survey are concluded in the section "Final remarks" and future studies are suggested at the next section.

5.2. Summary of the Research

This study explored how Turkish architectural practices managed their most strategic asset, namely knowledge. With this aim, semi-structured interviews were carried out with 15 architectural offices in the Çankaya District of Ankara. The interviews were based on a questionnaire which included issues of learning capabilities, knowledge sharing, accumulation and dissemination mechanisms and barriers and benefits of managing knowledge. The survey provided a general overview of knowledge management in Turkish architectural practices. The findings were presented based on the following three sections mentioned in the survey: i) knowledge sources, ii) knowledge sharing, accumulation and dissemination mechanisms and iii) barriers and benefits of knowledge management.

5.2.1. Knowledge Sources

Architectural organizations valued collecting knowledge and updating their knowledge repositories from different sources. Internet and printed material, in this

respect, were observed as the main external sources that architectural organizations focus. Also, governmental bodies, partners and clients were the external groups which organizations communicated frequently to share information. On the other hand, it was seen that the activity of searching and validating of knowledge were exhausting. Due to the advances in communication, the amount of knowledge and number of sources were tremendously increasing. The lack of standards in architectural processes caused the sources to be in different formats and conflicting with each other time to time. The scarcity of collective sources, either accessible online or in printed material, was the main obstacle in this aspect. Governmental and non-governmental institutions must put due effort in generating sources which could ease the process of collecting knowledge.

Beside the external sources, architectural organizations generated significant amount of knowledge in projects. They retrieved this knowledge mainly through process-based project learning (after-action reviews and post-project appraisals). On the other hand, documentation-based project learning (cased-based reports and learning histories) were not frequently utilized due to lack of time. Process-based project learning methods generated tacit knowledge for architects, but in order to have explicit sources which can easily be shared, organizations should focus on preparing evaluation documentation for their projects.

5.2.2. Knowledge Sharing, Accumulation and Dissemination Mechanisms

Due to the collaborative working environment of architectural projects within and out of office, face-to-face communication and electronic communication were main communication methods for sharing knowledge. Architectural design process includes considerable amount of tacit knowledge, which means that sharing tacit knowledge such as face-to-face communication, teamwork and meetings are commonly utilized. Even though, training is a crucial aspect of knowledge management strategies, architectural organizations preferred ad-hoc methods for improving their employees while working in projects. Methods such as utilizing

preset standards and leading new employees through useful job rotations could be utilized more frequently for a good start-up in sharing knowledge.

Even though, accumulation of knowledge was suggested as very important, advanced tools for accumulation and dissemination of knowledge were not implemented by organizations. Electronic documentation depending on specific categorization to each organization was preferred along with servers for supporting the dissemination of knowledge. Intranet, which has been introduced as an essential enabler of knowledge management strategies, was used by a small ratio of organizations. For better deployment of stored knowledge, architectural organizations may seek for appropriate tools such as data miners, project management software. Also, collecting and archiving architectural knowledge may be embedded into daily activities of all employees with the monitoring of appointed specialists (e.g. archivist or IT specialists).

5.2.3. Barriers and Benefits of Managing Architectural Knowledge

Throughout the survey, it was observed that the participant organizations emphasized the importance of managing architectural knowledge and claimed that improvements could be made within their offices. In the previous sections, it has been mentioned that organizations considered possible benefits of knowledge managements more effective than barriers against this activity. Moreover, it was seen that organizations expect internal benefits within their offices but neglected external benefits that were related with end-products and rewards. On the other hand, organizations put emphasis on barriers that were related with the AEC industry more than the barriers related with their organizational wheels.

5.3. Discussion

In this section, significant findings are further discussed in detail. The factors that are affecting architectural organizations in managing knowledge and expectations from knowledge management in the perspective of participants are considered according

to being external or internal. Depending on this comparison, another aspect of knowledge management is introduced.

5.3.1. External and Internal Factors

According to survey results, organizations believed that knowledge management provided advantages in managing architectural practices more efficiently. However, it was observed that the expected value from this activity was linked more strongly to internal benefits such as productivity, decreased re-work, enhanced problem solving, and employee satisfaction. External benefits such as client satisfaction, decreased project durations, increased profit, and innovation in design, on the other hand, were less important.

When the reasons behind this difference between the values derived from internal versus external benefits were observed, it was seen that internal barriers (such as employee resistance, insufficient funding, hard implementation of knowledge management and lack of top management support and infrastructure) were claimed to be easier to tackle by most organizations. On the contrary, the external barriers related to architectural industry (such as insufficient time, lack of standard processes, multi-disciplinary working environment and unique nature of projects) were considered as the main factors that were hindering possible benefits of knowledge management. The survey results implied that organizations were significantly affected by these external factors and thus they might not reflect their organizational values and performance to architectural design and overall profit as expected.

Further analysis of this issue revealed a common shared problem of architectural practices in Turkey. The participant organizations referred to the lack of large-scaled architectural organizations with *established institutional settings* in the AEC industry. In the following section, this problem is discussed considering the institutionalization in the architectural practice.

5.3.2. Institutionalization

Organization S1 defined the problem very clearly: "*Knowledge is limited by the continuity of the architect himself. Unfortunately, there may not be much difference between organizational knowledge and personal knowledge in our industry.*" 7 out of 15 organizations agreed that the lack of large scale architectural firms and the related lack of institutionalization had profound effects against a knowledge-based architecture environment. Organizations linked the origins of this problem to the current characteristics of the AEC industry in Turkey.

Currently, most of the organizations in architectural practice are very small scaled (1-5 architects) and more than half of them are individual proprietorships (Emmitt 2007, p.172). This suggests a strong link between company and head architect. The head architect determines the quality/quantity of the knowledge repository and also the life span of the company. For healthy management of knowledge, there should be a distinct organizational knowledge repository and adequate time for knowledge-based strategies to generate results. According to Tolbert and Zucker (1996, p.180-181), institutional organizations are defined as a development of shared definitions of empirically generated behaviors by types of actors. The authors state that these behaviors are generalized in such away that they become independent of the specific individuals who carry out the action. These organizations can also maintain the continuity of corporate identity. Institutionalization may hence provide adequate resources for architectural organizations to overcome some of the obstacles originated from AEC industry.

Through the survey, it was suggested that the most important aspect of knowledge management was to transmit organizational knowledge beyond individuals and generations. On the other hand, the greatest obstacle against knowledge management was the discontinuity of architectural offices. This occurs when executive architects may not continue working or when the architectural office cannot maintain doing business due to economical reasons. Architectural offices tend to shrink when they face an economical situation due to lack of capital and unpredictable work volume.

For a healthier business environment, the architectural organizations should embody large scale legal entities that are strong in economy and workforce with a long life-span. In the past, many qualified Turkish architectural offices have been dismissed due to the retirement of head architects. When the situation in foreign countries is considered, several architectural offices have managed to survive in similar situations by building up an institutional language, commitment to organization and unique knowledge repository. These features are also considered as the requirements to generate an architectural style that is specific and identifiable.

Architectural organizations may benefit from an institutional setting in the design process. Recording all activities in a process with defining better job and activity descriptions, organizations have a greater control on all aspects including the design process. Removing excessive subjectivity on how activities should progress may render architectural design process less dependant on single individuals. With a better control on design activities, it could be easier to capture and manage the architectural knowledge. Also, one of the main advantages of an institutional organization is the capability of performing all activities even in the absence of executives. In such environment, the responsibilities of company can be spread among employees. By doing so, organizations may provide flexibility and increase the work volume and also establish a more satisfying working environment for their employees. Through institutionalization, business environments can be achieved where employees remain within organizations and promote and finally keep the organizations working. Possessing such an organizational culture is the key factor for performing knowledge management mechanisms.

5.3.3. Barriers against Institutional Architectural Organizations

There are various reasons of why architectural offices cannot become institutional organizations. The most important factor is the economical condition of the AEC industry. It was suggested in the survey that the payments in Turkish architectural industry was rather low when compared to foreign countries. Consequently, the profits of architectural organizations were not allowing them to invest due amounts

required for expanding. The depreciation of architectural products, perspective of investors and the absence of a professional union against these factors were given as the reasons for the low-profit margin. Also, unsatisfied employees, due to low payments, tended to keep their business relations short-termed and preferred to establish new organizations.

In the survey, it was introduced that Turkish architectural industry was rather traditionalistic and not very constructive for changing this characteristic of its own. It was also given that there was not enough legal incentive for architectural organization to expand or unite. Features such as being long-termed, finishing large amount of projects could be rewarded more by the governmental institutions. Should there be more encouragement from industry and government; the participants had foreseen that architectural organizations would prefer to establish larger entities. On the other hand, while there were roadmaps on institutionalization for several other industries, there was not one for architectural industry. It was put forward that studies on such documents must be prepared by professional bodies and universities. In general, participant organizations agreed on the fact that these phenomena were rather new to Turkish architectural industry and it might take time for such developments to flourish.

It was also stated that there should be some improvements in the architectural education. One of the problems in this aspect was the lack of orientation for architecture students. It was suggested that there should be encouragement for specialization in the educational area so that new architects would be comfortable in the collaborative working environment. Architectural practice is not limited with design area, there are many other aspects. For institutional organizations where employees have distinct and clearly defined jobs, it can be useful for new architects to be aware of the different possibilities and be eager to work in collaborative environments.

5.4. Final Remarks

Managing knowledge is a critical activity for architectural organizations. Having already implementing knowledge management activities at a high level but in an ad-hoc system, the participant organizations have presented an eager approach towards knowledge-based strategies. On the other hand, organizations cannot invest adequate time, funding and workforce for knowledge management activities due to economical and industrial problems. The main findings of this study can be summarized as follows:

1. The benefits of managing architectural knowledge are identified as important by all of the participant organizations. The main benefits are seen as the increased productivity, decreased re-work and enhanced employee satisfaction. While, organizations champion knowledge management for improving such internal factors, the expectation towards end-results such as increased profit and innovation in design are seen to be neglected.

2. Lack of standard processes, insufficient time, and the unique nature of architectural projects are considered to be the main barriers against managing architectural knowledge. While organizations are observed to be managing barriers such as employee resistance, lack of management support and infrastructure, they are significantly affected by external factors.

3. The vulnerability of architectural organizations towards external barriers related with AEC industry requires a greater solution which is also suggested by the participants. Architectural offices can cope with economical and industrial problems successfully if they establish strong and large-scaled institutional organizations. The lack of institutional organizations with long-life span is regarded as the main deficient of the Turkish architectural practice.

4. One of the key areas where the knowledge management applications can benefit from is the educational platform. The IT and CAD tools have already brought new

design methods in the architectural practice and education. At this point, additional knowledge of CAD standards (where design representation is standardized by a set of rules) may constitute a fundamental solution to the lack of standard processes in representation in the design activity.

Alternative methods such as building information models (BIM), where all relevant information about a building is stored in a single 3-D model, can also be utilized in the educational institutions. Besides, exploring the new possibilities of this method, students may understand the ins and outs of the multi-disciplinary working environment of the architectural design. Experiencing the collaborative working environment in the educational area, architecture students may easily adapt themselves into knowledge management systems where roles and activities are clearly defined.

As mentioned earlier, companies may also use off-shelf software applications to facilitate a systematic accumulation and management of knowledge during design process. According to survey it was seen that organizations valued acquisition and accumulation of architectural knowledge. These software applications may provide basic but advantageous abilities for architectural organizations. Data-miners, data management software may be utilized without having much investment. Such methods can be suggested for organizations as initial steps in improving the management of architectural knowledge.

5. Organizations may apply knowledge-based strategies in order to utilize most out of their knowledge assets and they may be successful with a diligent effort. But, it is clear that as long as these organizations cannot survive through time, there will not be a cumulative benefit of managing knowledge to organizations themselves and to the architectural industry. Unless, organizations manage to transmit their knowledge repositories to somewhere else, valuable knowledge collected by them is lost forever. It is important that organizations continuously collect valuable information, validate and archive them as architectural knowledge and apply the best out of their knowledge repositories in projects through a long life-span. The end results actually

forms the overall knowledge repository of Turkish architecture, which all the architectural organizations can share and benefit from.

5.5. Future Studies

In accordance with the results presented in this study, several aspects for future studies can be underlined:

- Developing collective resources in architecture should be considered as an essential and initial activity for creating a knowledge-based industry. With the presence of easily accessible knowledge resources, organization can focus on managing their knowledge repositories without investing excessive work-force and time.
- Developing a knowledge management roadmap for architectural organizations should be a secondary step of this study, and case studies should be conducted for outlining a practical framework.
- Developing a roadmap for institutionalization in architectural practice may be necessary for organizations that become capable of managing their activities efficiently and ready for establishing stronger and clear business plans.

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APPENDIX A

SAMPLE OF INTERVIEW QUESTIONS

Dear sir or madam,

This survey is conducted as a part of the thesis study, "Exploring Knowledge Management in the Practice of Architecture", which is being prepared in Department of Architecture in Middle East Technical University by Cihan Kayaçetin under the supervision of Asst. Prof. Dr. Ali Murat Tanyer. The survey is designed for the architectural practice in Turkey, and all the information gathered is going to be kept confidential.

The study is investigating the condition of architectural offices in the developing Architecture-Engineering-Construction industry, regarding knowledge management. The information you'll provide is going to support the progress of architectural offices in knowledge management aspects.

The survey is consisting of two parts:

- At the first part, questions about the organizational settings are proposed in order to identify the characteristics of participants and their business choices. This part is consisting of 8 questions.

- At the second part, applications used in the architectural design process are questioned. The emphasis is on the paths that architectural knowledge follows in the project process. This part is consisting of 11 questions.

The survey is advised to be filled out by those who participate in the architectural design process. Thank you in advance for the support you give for this study.

1. ORGANIZATIONAL INFORMATION

A.1. Please answer to the questions about yourself and your company.

Name _____
Position _____
Occupation _____
Firm name _____
Firm address _____
Telephone/Fax no _____
E-mail address _____

A.2. Please notify the positions and number of your employees.

Executive personnel (director, assistants, etc.) _____
Technical personnel (architect, engineer, etc.) _____
Non-technical personnel _____
Total _____

A.3. Please notify the education level of your employees.

Undergraduate _____
Graduate _____
Doctorate _____
Other _____

A.4. What is the amount of projects finished (m2) in the last five years?

☐ 0 – 25.000 m^2
☐ 25.000 – 50.000 m^2
☐ 50.000 – 100.000 m^2
☐ 100.000 – 250.000 m^2
☐ Over 250.000 m^2

A.5. In what categories below, does your company undertake projects?

☐ Residential buildings
☐ Commercial buildings
☐ Industrial buildings
☐ Public buildings
☐ Transportation buildings
☐ Office buildings
☐ Hotel buildings
☐ Education facilities
☐ Sport facilities
☐ Health care facilities
☐ Restoration
☐ City planning
☐ Environmental design
☐ Interior design

A.6. In which design phases below, does your company participate?

- ☐ Pre-design phase
- ☐ Schematic design phase
- ☐ Design development phase
- ☐ Construction documentation
- ☐ Bidding phase
- ☐ Construction administration
- ☐ Post-design phase

A.7. Which characteristics below, would you describe your company with?

- ☐ Stable, formal management
- ☐ Flexible management
- ☐ Dynamic management
- ☐ Standard design solutions
- ☐ Client-oriented design solutions
- ☐ Innovative design solutions

A.8. Which of the statements below are valid for your organization?

- ☐ Our firm has a specific mission and long-termed objectives in the terms of knowledge management.
- ☐ The democratic management in our firm values the ideas and comments of employees.
- ☐ Our firm provides spiritual and material support for the development of employees.
- ☐ Our firm provides an open and trustworthy environment where all employees share knowledge.
- ☐ Knowledge sharing environment with other firms is planned to be provided by our firm.
- ☐ Our learning capability provides us an important competitive advantage.

2. KNOWLEDGE MANAGEMENT APPLICATIONS

Dear sir or madam

In this part, the path that architectural knowledge follows during project process within your organization is investigated. This part is considered in two sub-headings.

1. Classification of architectural knowledge,

a) Design knowledge is identified as the knowledge that is required for generating architectural design, project ideas and documentation produced with this purpose. In this type of knowledge, design constraints, planning ideas, project estimates, drawings and specifications are included.

b) Application knowledge is identified as the general construction and building knowledge that is required for applying design ideas into projects and documentation produced with this purpose. In this type of knowledge, unit costs, productivity, equipment and applied methods are included.

c) Strategic knowledge is identified as the knowledge about your company, competitors, employees, clients, partners and industry that enables your company doing business in the AEC industry. In this type of knowledge, client information, partner information, employee information, information on competitors and market-country are included.

Please verify the type of acquired, shared, stored and deployed knowledge in the questions according to the explanation given above.

2. Necessary applications and methods in order to acquire, share, store and deploy architectural knowledge are introduced in the following questions. Please verify the frequency of usage and level of importance of these applications in your company.

B.1. Which external sources below do you attend in order to gain information? Please give examples from the sources you consider important.

Sources	Design	App.	Str.	Frequency level	Example
Seminars	☐	☐	☐	_____	_____
Congresses	☐	☐	☐	_____	_____
Expositions	☐	☐	☐	_____	_____
Tradeshows	☐	☐	☐	_____	_____
Printed material	☐	☐	☐	_____	_____
Academic studies	☐	☐	☐	_____	_____
Internet	☐	☐	☐	_____	_____

B.2. Which parties below do you communicate in order to gain information? Please give examples from the parties you consider important.

Parties	Design	App.	Str.	Frequency level	Example
Clients	☐	☐	☐	_____	_____
Partners	☐	☐	☐	_____	_____
Competitors	☐	☐	☐	_____	_____
Universities	☐	☐	☐	_____	_____
Consultants	☐	☐	☐	_____	_____
Governmental bodies	☐	☐	☐	_____	_____
Non-governmental bodies	☐	☐	☐	_____	_____
Foreign organizations	☐	☐	☐	_____	_____

B.3. Which applications do you use to improve your organizational knowledge repository?

Applications	Design	App.	Str.	Frequency level
Benchmarking	☐	☐	☐	_____
Environmental scanning	☐	☐	☐	_____
After action review	☐	☐	☐	_____
Post project appraisal	☐	☐	☐	_____
Cased based reports	☐	☐	☐	_____
Learning histories	☐	☐	☐	_____

B.4. How do you share knowledge with your employees?

Applications	Frequency level
Team work	_____
Formal, regular meetings	_____
Informal, unplanned meetings	_____
Internal seminars	_____
Job rotation	_____
Brainstorming	_____
Face-to-face communication	_____
Electronic communication	_____

B.5. How do you share your design ideas with your employees?

Applications	Frequency level
Face-to-face communication	_____
Reports	_____
Hand drawings	_____
CAD drawings (2-D)	_____
Digital modeling (3-D)	_____

B.6. How do you share your construction documentation with your employees?

Applications	Frequency level
Face-to-face communication	_____
Reports	_____
Hand drawings	_____
CAD drawings (2-D)	_____
Digital modeling (3-D)	_____

B.7. How and who stores important knowledge in your company?

Who	Design	App.	Str.	Format	Availability
Project manager	☐	☐	☐	_____	_____
Head architect	☐	☐	☐	_____	_____
Group leader	☐	☐	☐	_____	_____
Technical personnel	☐	☐	☐	_____	_____
IT-specialist	☐	☐	☐	_____	_____

B.8. Which applications do you utilize in order to support re-use of knowledge within your company?

Applications	Design	App.	Str.	Frequency level
Electronic documentation	☐	☐	☐	_____
Server	☐	☐	☐	_____
Intranet	☐	☐	☐	_____
Online databases	☐	☐	☐	_____
AI-based decision support systems	☐	☐	☐	_____
Web-based project management systems	☐	☐	☐	_____

B.9. What is the importance level of components below in the management of knowledge?

Components	Importance level
Individual learning	_____
Learning from other parties	_____
Organizational learning mechanisms	_____
Knowledge sharing	_____
Knowledge accumulation	_____
Knowledge dissemination	_____
Organizational culture	_____

B.10. What are the barriers against the application of knowledge management systems?

Barriers	Importance level
Employee resistance	_____
Lack of management support	_____
Insufficient time	_____
Insufficient funding	_____
Lack of infrastructure	_____
Unique nature of architectural projects	_____
Multi-disciplinary parties involved	_____
Lack of standard processes	_____
Hard to implement	_____

B.11. What are the possible benefits of applying a knowledge management system?

Benefits	Importance level
Decreased re-work	_____
Decreased project duration	_____
Increased productivity	_____
Increased profit	_____
Enhanced problem solving	_____
Employee satisfaction	_____
Client satisfaction	_____
Innovation	_____

APPENDIX B

SAMPLE OF INTERVIEW QUESTIONS (TURKISH)

Sayın firma çalışanı,

Bu anket çalışması Orta Doğu Teknik Üniversitesi Mimarlık Bölümü Yapı Bilimleri Yüksek Lisans Programında hazırlanmakta olan "**Mimari Ofislerde Bilgi Yönetimi**" konulu tez çalışması için yapılmaktadır. Anket, Türkiye'deki mimarlık sektörüne yöneliktir ve bu kapsamda sizlerden alınan bilgiler kesinlikle gizli tutulacaktır.

Bu çalışma, gelişmekte olan yapı sektöründe mimari ofislerin bilgi yönetimi açısından durumunu incelemektedir. Vereceğiniz bilgiler, mimari ofislerin bilgi yönetimi konusunda ilerlemesini desteklemekte bir adım olacaktır.

Anket iki bölümden oluşmaktadır:

- **Birinci bölümde**, ankete katılanların özellikleri ve iş tercihlerinin belirlenmesi için kurumsal bilgiler sorgulanmaktadır. Bu bölüm **8 sorudan** oluşmaktadır.

- **İkinci bölümde** firmanızda proje üretim sürecinde ve bu süreci desteklemede kullandığınız uygulamalar sorgulanmaktadır. Önem verilen konu, mimari bilginin proje sürecinde nasıl bir yol izlediğidir. Bu bölüm **11 sorudan** oluşmaktadır.

Anketin mimari tasarımda rol alan kişiler tarafından doldurulması önerilmektedir**.** Bu çalışmaya verdiğiniz destek için şimdiden çok teşekkür ederim.

A. KURUMSAL BİLGİLER

A.1. Çalışmakta olduğunuz firma ve kendiniz ile ilgili soruları cevaplayınız.

Adınız _____
Firmadaki konumunuz _____
Mesleğiniz _____
Firma adı _____
Firma adresi _____
Telefon/Fax no _____
E-mail _____

A.2. Firmanızda çalışanların konumlarını ve sayılarını belirtiniz.

Yönetici personel (genel müdür, bölüm şefleri vb.) _____
Teknik personel (mimar, mühendis, teknisyen vb.) _____
Teknik olmayan personel _____
Toplam _____

A.3. Firmanızda çalışanların eğitim durumlarını ve sayılarını belirtiniz.

Lisans _____
Yüksek lisans _____
Doktora _____
Diğer _____

A.4. Son beş sene içinde firmanız tarafından tamamlanan proje miktarını belirtiniz.

☐ 0 – 25.000 m^2
☐ 25.000 – 50.000 m^2
☐ 50.000 – 100.000 m^2
☐ 100.000 – 250.000 m^2
☐ 250.000 m^2 üzeri

A.5. Firmanız hangi proje türlerinde üretim yapmaktadır?

☐ Konut binaları
☐ İş merkezleri
☐ Endüstriyel binalar
☐ Kamu binaları
☐ Ulaşım binaları
☐ Ofis binaları
☐ Otel binaları
☐ Eğitim tesisleri
☐ Spor tesisleri
☐ Sağlık tesisleri
☐ Restorasyon
☐ Şehir planlama
☐ Çevresel tasarım
☐ İç mimarlık

A.6. Firmanız proje tasarım aşamalarından hangilerinde bulunmaktadır?

- ☐ Tasarım ön araştırması
- ☐ Avan proje aşaması
- ☐ Tasarım geliştirme aşaması
- ☐ Uygulama proje aşaması
- ☐ İhale aşaması
- ☐ Yapım yönetimi
- ☐ Proje sonrası değerlendirme

A.7. Size göre firmanız daha çok hangi özellikleri nedeniyle tercih edilmektedir?

- ☐ Sistemli çalışma ortamı
- ☐ Esnek yönetim tarzı
- ☐ Dinamik yönetim tarzı
- ☐ Güvenilir tasarım çözümleri
- ☐ Müşteriye yönelik çözümler
- ☐ Yenilikçi özgün tasarımlar

A.8. Aşagıdakilerden hangileri firmanızın kültürel altyapısı için geçerli olabilir?

- ☐ Firmamızın bilgi yönetimi konusunda belli bir misyonu ve uzun vadeli amaçları vardır.
- ☐ Firmamızın demokratik yönetim tarzı çalışanlarımızın görüş ve açıklamalarını önemser.
- ☐ Firmamız, çalışanlarımızın kendilerini geliştirmelerini maddi ve manevi anlamda destekler.
- ☐ Firmamızda, herkesin bilgi paylaşımı gerçekleştirebileceği açık ve güvenilir bir ortam vardır.
- ☐ Firmamızca, rakip firmalarla bilgi alışverişi ve paylaşım ortamı yaratılması amaçlanmaktadır.
- ☐ Öğrenme yeteneğimiz ve kapasitemiz, firmamıza önemli bir rekabet avantajı sağlar.

B. BİLGİ YÖNETİMİ UYGULAMALARI

Sayın firma çalışanı,

Bu bölümde, firmanızdaki bilginin proje sürecinde izlediği yol araştırılmaktadır. Bu bölüm iki alt konu başlığında incelenmektedir.

1. Mimari bilginin sınıflandırılması,

a) **Tasarım bilgisi**; mimari tasarım yapabilmek, proje fikilerini ortaya çıkarabilmek için gerekli olan tasarım bilgisi ve bu amaçla üretilen dokümanlar olarak belirlenmiştir. Bu bilgi sınıfında, tasarım girdileri, tasarım fikirleri, planlama fikirleri, proje tahminleri, çizimler ve şartnameler gibi öğeler yer almaktadır.

b) **Uygulama bilgisi**; tasarımların uygulamaya dökülebilmesi için gereken proje ve yapım bilgisi ve bu amaçla üretilen dokümanlar olarak belirlenmiştir. Bu bilgi sınıfında, birim maliyetler, verimlilik, ekipman ve uygulanan metotlar gibi öğeler bulunmaktadır.

c) **Stratejik bilgi**; firmanızın inşaat sektöründe iş yapabilmesini sağlayan, diğer firmalarla, kendi firmanızla, çalışanlarınızla, müşterilerinizle, ortaklarınızla ve inşaat sektörüyle ilgili bilgiler olarak belirlenmiştir. Bu bilgi sınıfında, müşteri bilgileri, taşeron bilgileri, çalışan bilgileri, rakip firma bilgileri ve ülke - pazar bilgileri gibi öğeler bulunmaktadır.

Lütfen bu açıklama doğrultusunda, sorunun içeriğine göre edinilen, paylaşılan, saklanan ya da yeniden kullanılan **bilgi türlerini işaretleyiniz.**

2. Mimari bilgilerin elde edilmesi, saklanması, paylaşılması ve yeniden kullanılmasında gerekebilecek **uygulamalar** sorularda belirtilmiştir. Bu uygulamaların firmanızda kullanılma **sıklıkları** veya **etkileri** gibi özelliklerin derecelerini belirtiniz.

B.1. İhtiyaç duyduğunuz bilgiye ulaşmak için başvurduğunuz dış kaynaklar nelerdir? Lütfen önemli bulduğunuz kaynaklardan örnekler veriniz.

Kaynak	Tas.	Uyg.	Str.	Sıklık derecesi	Örnek
Seminerler	☐	☐	☐	_____	_____
Kongreler	☐	☐	☐	_____	_____
Sergiler	☐	☐	☐	_____	_____
Fuarlar	☐	☐	☐	_____	_____
Yayınlar	☐	☐	☐	_____	_____
Akademik çalışmalar	☐	☐	☐	_____	_____
İnternet	☐	☐	☐	_____	_____

B.2. İhtiyaç duyduğunuz bilgiye ulaşmak için başvurduğunuz kurumlar nelerdir? Lütfen önemli bulduğunuz kurumlardan örnekler veriniz.

Kurum	Tas.	Uyg.	Str.	Sıklık derecesi	Örnek
Müşteriler	☐	☐	☐	_____	_____
Ortaklar	☐	☐	☐	_____	_____
Sektörel rakipler	☐	☐	☐	_____	_____
Üniversiteler	☐	☐	☐	_____	_____
Danışmanlar	☐	☐	☐	_____	_____
Kamu kuruluşları	☐	☐	☐	_____	_____
Serbest kuruluşlar	☐	☐	☐	_____	_____
Yabancı kuruluşlar	☐	☐	☐	_____	_____

B.3. Bilgi kütüphanenizi geliştirmek için hangi uygulamaları kullanıyorsunuz?

Uygulama	Tas.	Uyg.	Str.	Sıklık derecesi
Kıyaslama (firma içi/diğer firmalarla karşılaştırma)	☐	☐	☐	_____
Çevresel araştırma (sektörle ilgili stratejik araştırma)	☐	☐	☐	_____
Müdahale sonrası inceleme (proje sürecinde işlem kontrolü)	☐	☐	☐	_____
Proje sonrası değerlendirme (genel proje kontrolü)	☐	☐	☐	_____
Vakalara dayanan belgeleme (işlem özetleri belgelenmesi)	☐	☐	☐	_____
Geçmiş projelerden öğrenme (proje özetlerinin belgelenmesi)	☐	☐	☐	_____

B.4. Firmanızdaki bilgileri çalışanlarınızla hangi ortamlarda paylaşırsınız?

Uygulama	Sıklık derecesi
Takım çalışması	_____
Resmi, düzenli toplantılar	_____
Planlanmamış toplantılar	_____
Firma içi seminerleri	_____
İş rotasyonu	_____
Beyin fırtınası	_____
Yüz yüze iletişim	_____
Elektronik ortam (e-mail, web sayfası, vb.)	_____

B.5. Tasarım fikirlerinizi çalışanlarınız ve ortaklarınızla nasıl paylaşırsınız?

Uygulama	Sıklık derecesi
Yüz yüze iletişim	_____
Raporlar	_____
El çizimleri	_____
CAD çizimleri (İki boyutlu)	_____
Dijital modelleme (Üç boyutlu)	_____

B.6. Uygulama dosyalarınızı çalışanlarınız ve ortaklarınızla nasıl paylaşırsınız?

Uygulama	Sıklık derecesi
Yüz yüze iletişim	_____
Raporlar	_____
El çizimleri	_____
CAD çizimleri (iki boyutlu)	_____
Dijital modelleme (Üç boyutlu)	_____

B.7. Bilgilerinizi güvenli ve ulaşılabilir durumda nasıl saklıyorsunuz?

Kim	Tas.	Uyg.	Str.	Biçim	Ulaşılabilirlik
Proje yöneticisi	☐	☐	☐	_____	_____
Baş mimar	☐	☐	☐	_____	_____
Grup lideri	☐	☐	☐	_____	_____
Teknik personel	☐	☐	☐	_____	_____
Bilgi işlem uzmanı	☐	☐	☐	_____	_____

B.8. Bilgilerin yeniden kullanılmasını desteklemek için hangi bilişim uygulamalarından faydalanıyorsunuz?

Uygulama	Tas.	Uyg.	Str.	Sıklık derecesi
Dosyalama	☐	☐	☐	_____
Sunucu (Server)	☐	☐	☐	_____
Kurum içi ağ (Intranet)	☐	☐	☐	_____
Çevirimiçi veri tabanları	☐	☐	☐	_____
Program tabanlı karar destek sistemleri	☐	☐	☐	_____
Web tabanlı proje yönetim sistemleri	☐	☐	☐	_____

B.9. Size göre aşağıdaki öğelerin bilgi yönetimi uygulamasındaki önem dereceleri nelerdir?

Öğeler	Önem derecesi
Dış kaynaklardan bilgi edinme	_____
Diğer kurumlardan bilgi edinme	_____
Bilgi kütüphanesinin geliştirilmesi	_____
Çalışanlar arasında bilgi paylaşımı	_____
Bilginin saklanması	_____
Bilginin kullanımında bilişim uygulamaları	_____
Kültürel altyapı	_____

B.10. Size göre firmanızda bilgi yönetimi uygulamalarının yaygınlaşmasını engelleyen öğeler nelerdir?

Engeller	Etki derecesi
Çalışan isteğinin azlığı	_____
Yönetici desteğinin azlığı	_____
Yetersiz zaman	_____
Yetersiz finansman	_____
Yetersiz altyapı	_____
Mimari projelerin kendince benzersiz oluşu	_____
Farklı disiplinlerden taraflarla çalışma	_____
Standart iş süreçlerinin bulunmayışı	_____
Uygulama zorlukları	_____

B.11. Size göre firmanızda uygulanacak bir bilgi yönetimi sisteminin sağlayabileceği faydalar nelerdir?

Faydalar	Etki derecesi
İş tekrarlarının azalması	_____
Proje süresinin azalması	_____
Verimliliğin arttırılması	_____
Gelirin arttırılması	_____
Sorun çözümlemesinde kolaylık	_____
Çalışan memnuniyeti	_____
Müşteri memnuniyeti	_____
Yenilikçilik	_____

APPENDIX C

STATISTICAL ANALYSIS TABLES

Table C.1. Two sample dependent Student's t-test for the hypothesis I

Organization	Mean Barriers	Mean Benefits	Mean difference	$\overline{D}$	Standard deviation	t-stat	p-value
A	2.778	4.125	-1.347	-0.474	0.719	-2.552	0.023
B	3.333	3.625	-0.292	-0.474			
C	2.889	3.875	-0.986	-0.474			
D	3.111	3.375	-0.264	-0.474			
E	2.889	3.750	-0.861	-0.474			
F	2.556	3.750	-1.194	-0.474			
G	3.000	4.250	-1.250	-0.474			
H	3.222	3.375	-0.153	-0.474			
I	3.333	3.625	-0.292	-0.474			
J	3.444	3.375	0.069	-0.474			
K	3.667	3.625	0.042	-0.474			
L	3.556	2.625	0.931	-0.474			
M	3.778	3.375	0.403	-0.474			
N	4.111	4.375	-0.264	-0.474			
O	3.222	4.875	-1.653	-0.474			

Table C.2. Two sample dependent Student's t-test for the hypothesis II

Organization	Internal barriers	External barriers	Mean difference	$\overline{D}$	Standard deviation	t-stat	p-value
A	3.200	2.250	0.950	-0.763	0.910	-3.248	0.006
B	3.400	3.250	0.150	-0.763			
C	2.200	3.750	-1.550	-0.763			
D	3.200	3.000	0.200	-0.763			
E	2.000	4.000	-2.000	-0.763			
F	2.400	2.750	-0.350	-0.763			
G	2.600	3.500	-0.900	-0.763			
H	3.400	3.000	0.400	-0.763			
I	2.800	4.000	-1.200	-0.763			
J	2.600	4.500	-1.900	-0.763			
K	3.400	4.000	-0.600	-0.763			
L	3.000	4.250	-1.250	-0.763			
M	3.600	4.000	-0.400	-0.763			
N	3.600	4.750	-1.150	-0.763			
O	2.400	4.250	-1.850	-0.763			

Table C.3. Two sample dependent Student's t-test for the hypothesis III

Organization	Internal benefits	External benefits	Mean difference	$\overline{D}$	Standard deviation	t-stat	p-value
A	4.250	4.000	0.250	0.633	0.611	4.153	0.001
B	4.000	3.250	0.750	0.633			
C	4.000	3.750	0.250	0.633			
D	3.250	3.500	-0.250	0.633			
E	4.500	3.000	1.500	0.633			
F	4.000	3.500	0.500	0.633			
G	4.250	4.250	0.000	0.633			
H	3.750	3.000	0.750	0.633			
I	3.500	3.750	-0.250	0.633			
J	3.750	3.000	0.750	0.633			
K	4.250	3.000	1.250	0.633			
L	3.250	2.000	1.250	0.633			
M	4.250	2.500	1.750	0.633			
N	4.750	4.000	0.750	0.633			
O	5.000	4.750	0.250	0.633			